Research article

Teaching and learning musical instruments through ICT: the impact of the COVID-19 pandemic lockdown

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ABSTRACT

The COVID-19 lockdown in education institutions required music teachers to use ICT to continue teaching. This research study, with the use of a Likert type online questionnaire, analyses the ICT activities carried out during this period and the learning conceptions they reflect. The questionnaire consisted of the description of activities which varied, depending on the learning promoted (reproductive or constructive), the learning outcomes (verbal, procedural, or attitudinal), the type of assessment to which the activities were directed, and the presence of cooperative activities. The teachers had to indicate the frequency with which they carried out these activities. The questionnaire was completed by 254 instrumental music teachers from different types of institutions and different levels. The main study outcome was that teachers used reproductive activities more frequently than constructive ones. We also found that most activities were those favouring verbal learning and assessment. The cooperative activities were the least frequent. Finally, through a cluster analysis, we identified three teaching profiles depending on the frequency and type of ICT used: Passive, Active, and Interpretative. The variable that produced the most consistent differences was previous ICT use.

1. Introduction

The sudden closure of schools in March 2020 due to the Covid-19 pandemic led to severe repercussions in education that were perhaps even more severe for the teaching of music. We suggest that the pandemic represents a *critical incident* in the field (Butterfield et al., 2005; Monereo, 2010) that could in itself offer an opportunity to change or improve accepted traditional practices in music teaching and, more specifically, the training of instrumentalists. However, it was also possible that in such a critical situation, teachers would limit themselves to keep their usual teaching practices in the new virtual spaces, without introducing reflection-based changes in them. In this study, the question we posed is whether the pandemic—understood as a critical incident that has led to the forced adoption of technology-mediated learning—served to transform teaching practices that had to migrate to virtual classrooms, or if the new ways of teaching simply represented an

adaptation of old forms of education based on the teacher-centred conservatory method.

To date, few studies have been conducted of the teaching practices utilized in music classrooms during this period, or the activities that were carried out in those classrooms. Most studies have focused, for instance, on the effects of information and communications technology (ICT; e.g., Kesendere et al., 2020), students' technical difficulties (e.g., Daubney and Fautley, 2020; Ozer and Ustün, 2020), and interpersonal relationships (Philippe et al., 2020; Schiavio et al., 2021). We found a small number of qualitative studies analysing teaching and learning practices that were based on interviews (e.g., Biasutti et al., 2021) with small selective samples of teachers, who showed creative and innovative responses to the need of transforming their classes into virtual classrooms. However, we did not find studies involving larger representative samples. In this article, building on research in primary and secondary schools reported by Pozo et al. (2021), we analyse the practices of

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instrumental music teachers in Spain during this period of crisis and the broader conceptions underlying those practices.

2. The use of digital technologies in music classrooms: transformation or reproduction?

Information and communication technologies (ICT) are used only to a limited extent in the teaching of musical instruments, despite the fact that highly promising technologies have been developed in other educational contexts (Ertmer et al., 2015; Pozo et al., 2021). This development suggests that ICT could be a valuable resource for music teaching (Bauer, 2020; Crawford, 2017; Ruthmann and Mantie, 2017; Savage, 2010), and Pozo et al. (in press) argue that it can be effective in student-centred music teaching for constructive learning and skills training. For example, some authors have shown that ICT can help students focus on their own body as a source of expressivity, self-control, and reflection (e.g., Boucher et al., 2019). Others have insisted that the use of ICT in music teaching can aid the development of communication skills and social interaction (e.g., Serrano, 2017), the ability to process feedback (Guerrero, 2014; Lepa et al., 2015), overall creativity and musical composition (Freedman, 2013), and even performance on certain instruments (Cano et al., 2014; Chao-Fernandez et al., 2017).

Despite the proposed benefits of ICT, many studies have shown that it is rarely used in music teaching other than as a way of motivating students. It is not used to change traditional teaching and learning practices, but rather to reinforce them (Savage, 2010; Serrano, 2017). This limited and uncreative use of ICT in music classrooms reflects the findings of large-scale international studies on the integration of information technologies in schools, which demonstrate that learning outcomes are not improved when traditional teaching methods incorporating ICT are used (Biagi and Loi, 2013). In fact, an OECD report summarising decades of results from the Programme for International Student Assessment (PISA) concluded that "[they] also show no appreciable improvements in student achievement in reading, mathematics or science in the countries that had invested heavily in ICT for education" (OECD, 2015, p. 3).

There may be various reasons for the apparent contradictions between the theoretical advantages of employing ICT in the music classroom and the disappointing outcomes associated with its limited use in practice. Several authors assert that changes in learning take place not because of the availability of digital technologies in the classroom, but because of the ways they are used (Comi et al., 2017; Gorder, 2008). These are often described as either *teacher-centred* (although *content-centred* might be more accurate), because the important thing is the content that teachers manage (Ertmer et al., 2015) and deliver (Gorder, 2008), and *student-centred*, because the students select, organise, and create the digital information they process, thus developing and using skills such as autonomy, collaboration, and critical thinking.

Tondeur et al. (2017) argue that a constructivist conception of learning is required if ICT is to be effectively integrated into education. This means adopting a student-centred, constructive approach in which the student is the agent of their own learning. In contrast, a reproductive approach is more typical in music classrooms, where the student simply repeats the information provided by the teacher. While experimental studies of the use of ICT in classrooms have shown that student-centred approaches are more successful, most investigations of classroom practices find that they consist of the one-way delivery of information by teachers to students, and that ICT is merely a substitute for other, more traditional resources (de Aldama and Pozo, 2016; Loveless and Dore, 2002; Sigalés et al., 2008).

According to Ertmer (1999), there are two types of barriers to the replacement of a content-centred approach with a student-centred approach. One is organisational; for example, a particular school or institution might lack an electronic network or access to devices, or there might be teachers and/or students who lack adequate technological resources—as it is in the case of the COVID-19 pandemic. The other

barrier, harder to remove, consists of the implicit beliefs and conceptions of teaching and learning held by the teachers.

3. Teachers' beliefs about teaching and learning through ICT

Teachers' beliefs about teaching and learning—the ways in which they view the role of content, their own role, and that of their students—are the best predictors of how they use ICT in the classroom (Ertmer et al., 2015). Research has identified at least two types of beliefs (e.g., Fives and Gill, 2015; Hofer and Pintrich, 2002; in music, Pozo et al., in press). One represents the traditional view that learning is essentially reproductive, and that teaching should be content-centred, while the other represents the constructivist view that learning should be student-centred. Teachers with constructivist beliefs tend to use ICT to a greater extent than teachers with more traditional beliefs (Ertmer et al., 2015), and with the aim of developing students' problem-solving skills (Tondeur et al., 2017). Teachers with traditional reproductive beliefs tend to use ICT to present information, set tasks, and pose questions to students. The teacher- or content-centred teaching belief is very close to the so-called conservatory model (Pozo et al., in press; Tregear et al., 2016), in that

> "historically, the predominant relationship between teacher and student in instrumental instruction has been described as a master-apprentice relationship, where the master usually is looked at as a role model and a source of identification for the student, and where the dominating mode of student learning is imitation." (Jørgensen, 2000, p. 68, p. 68)

Music teaching can thus be described as content-centred, with music as the content. Students are encouraged to learn musical scores and acquire mastery of the instrument they play, for example, using reproductive methods. Such learning typically produces shallow representations of the score and the technical ability to carry out procedures and routines on the instrument (Pozo et al., in press). Constructivist views of music teaching, in contrast, inform a student-centred approach fostering more complex ways of learning symbols that encourage a deeper processing of the score, a more strategic approach to the instrument (Marín et al., 2013), and other outcomes such as the acquisition of attitudes and values in relation to music, and greater expressivity when playing (e.g., Casas-Mas et al., 2015).

However, as shown by Ertmer et al. (2015), these reproductive and constructivist views are not dichotomous; rather, they form parts of a continuum of conceptions and approaches to teaching. Thus, in addition to the two approaches outlined above, a third, intermediate conception, called *interpretative*, has been identified (Pozo et al., 2021). The interpretative conception still assumes that the goal of learning is reproductive; however, instead of focusing solely on musical content, the teacher designs and directs activities to control the psychological processes of the student (motivation, concentration, etc.) that facilitate this learning. Studies have shown that the conceptions underpinning the interpretative approach are often shared by music students and teachers (e.g., Bautista et al., 2010; López-Íñiguez et al., 2014; Marín et al., 2013).

These conceptions are neither one-dimensional nor exclusive, but rather appear to be part of flexible profiles, composed of various aspects of different beliefs and conceptions that are then activated depending on the educational context and other variables (Tondeur et al., 2017). In the case of instrumental music, three different profiles have been identified—direct, interpretative and constructive—, all of which are characterized by the inclusion of several elements from different conceptions (Bautista et al., 2010; López-Íñiguez et al., 2014).

Researchers have also studied the relationship between teachers' beliefs about teaching and their actual practices (e.g., Buehl and Beck, 2015). There is usually a critical gap between them such that beliefs are more advanced than practice, constituting a methodological issue that should be considered in future research (Ertmer et al., 2015). Many

studies of the use of digital technologies in music are inquiries into teachers' general beliefs on the subject, and usually report that teachers are optimistic about the promise of ICT (Chen, 2017; Serrano, 2017). However, when an inquiry goes beyond general beliefs to explore the use of specific practices, the findings reveal the traditional use of ICT (de Aldama and Pozo, 2016).

In the present study, we asked not only about music teachers' activities involving ICT during the lockdown provoked by the pandemic but also whether these activities were seen as being closer to reproductive or constructivist views and if their components were organised into different profiles. Furthermore, we chose to analyse the practices teachers declared they actually used as a means of addressing their specific conceptions on teaching methods and how students learn to play instruments.

4. Variables that affect the uses of ICT

In addition to these different conceptions, other personal and social variables affect the use of ICT. In terms of gender, it appears that men are more favourably disposed to the idea of using ICT in music education (Suki, 2011), although differences between men and women are not so clear when the ways they use ICT in music classrooms rather than their beliefs are analysed (Guerrero, 2014). When considering the effect of teaching experience, we found that more experienced teachers usually had more reproductive conceptions than those with less experience. This was the case for music education (Bautista et al., 2010; López-Íñiguez et al., 2014) and other educational contexts (Baek et al., 2008; Inan and Lowther, 2010; Mathews and Guarino, 2000) although other studies have found no relationship between teaching experience and preference for a particular approach (Gorder, 2008); neither have other studies found that less experienced teachers have less constructivist conceptions (Guerrero, 2014; Pozo et al., 2021). Students' educational level appears to affect teachers' conceptions, as those who teach at higher levels usually allowed their students more autonomy and responsibility for their own learning, while those who teach at lower levels tended to use a more direct approach (Bonastre et al., 2017). On the other hand, although differences have not been identified so far between those who share the same educational culture but teach different musical instruments, no research has yet been conducted to compare the use of digital technologies in the teaching of different instruments.

Finally, the extent to which teachers have already used ICT has also been shown to influence both quantity of subsequent use and quality (i.e., teachers' ability to use it constructively) (Ertmer et al., 2015; Pozo et al., 2021). In that regard, although differences have not been identified so far between those who share the same educational culture but teach different musical instruments, no research has yet been conducted to compare the use of digital technologies in the teaching of different instruments. Certainly, the COVID-19 crisis, through the mandatory classrooms lockdown, forced many teachers unaccustomed to the educational use of digital technologies to use them for the first time. According to a study, only 30% of teachers in Spain had, before this lockdown, some type of experience that was not based on the face-to-face teaching modality (i.e., Luengo and Manso, 2020). But this scarce experience was not due to the lack of digital technological resources available to them, but because they decided not to use them in their teaching. According to the same study, 83.3% of students had at least one device with internet access available tot hem, and 82.7% had broadband (Luengo and Manso, 2020). Almost two-thirds of teachers used platforms provided by administrations or educational centers during the pandemic, while between 20% and 30% of them used private platforms (Luengo and Manso, 2020). Yet, many teachers acknowledged that they were not prepared to use these devices in their classrooms. For instance, only 40% of teachers believe they have received adequate training in methodologies and evaluation through virtual platforms (Luengo and Manso, 2020). In this context, it can be argued that during the lockdown there were many type I barriers that prevented the use of ICT—according to the

terminology of Ertmer (1999). Thus, what motivated us to undertake this study was to analyze the other possible barriers, the type II, linked to the conceptions and beliefs of teachers about the use of ICT in music classrooms.

5. Objectives

The purpose of this study was to analyse the activities that instrumental music teachers posed to their students using ICT during the pandemic lockdown. Its objectives were to:

1. Find out how often teachers provided such activities and the effects of variables such as gender, teaching experience, previous use of ICT, and music teaching speciality, on how often they were provided;
2. Analyse the type of learning (reproductive or constructive) used most frequently and which of the before-mentioned variables impacted this preference;
3. Identify the intended learning outcomes (verbal, procedural, or attitudinal) of these activities, and the effects of the variables on these outcomes;
4. Identify teaching profiles associated with the use of ICT, and their possible relationships with the variables.

6. Method

6.1. Survey

An online survey was carried out using the Qualtrics platform. A survey previously administered in a study of the use of ICT in primary and secondary education during the pandemic lockdown (Pozo et al., 2021) was adapted to instrumental music teaching, emphasizing the digital environments in which the teaching took place. Like the survey on which it was based, it was in two parts. The first requested personal and professional information (see Table 2 below), and the second consisted of 36 items describing different teaching activities and requiring respondents to state how often they carried out each of them out, using a Likert-type rating scale (1 = *never*, 2 = *on one occasion*, 3 = *on more than one occasion*; 4 = *regularly*). As can be seen in Table 1 the survey included three subscales: learning approach (Reproductive and Constructive learning), types of learning outcome (Verbal, Procedural, and Attitudinal), and Assessment and Cooperation activities. Thus, the survey consisted of 8 items describing activities oriented to each of the following subscales: 1) verbal learning, 2) procedural learning, 3) attitudinal learning, and 4) assessment. In each subscale, 4 items were oriented to reproductive activities and 4 to constructive ones. Finally, there were 4 items of constructive nature under another subscale related to cooperative activities.

6.2. Participants

Links to the survey were sent via email to hundreds of music teachers at public and private conservatories and music schools throughout Spain, and also via social media and associations connected to music education and psychology in Spain. The survey was open from mid-May until the end of June 2020. A total of 254 teachers responded to the survey. Five were eliminated from the sample because they did not teach in Spain and six were eliminated because they responded to over 60% of the items with *on more than one occasion* and *regularly*. The final sample consisted of 243 teachers of whom 184 taught at conservatories and 50 in music schools, while 9 gave extracurricular music classes. The conservatory teachers and extracurricular music teachers taught students individually, typically for 1 h a week each, whereas the music school teachers gave group classes twice a week. Table 2 describes the characteristics of the respondents. Note that the sum of all the variables does not add up to this total because some values were so unusual that they were not considered in the statistical analyses.

Table 1. Structure and examples of the questionnaire items.

	Reproductive		Constructive	
	N	Example of item	N	Example of item
Verbal Learning	4	I send them the scores with the same indications I would give in the face-to-face class. Then, when I start the next online class, I ask them questions to see if they remember the indications.	4	I send them different versions of the same piece so they can compare them and then, depending on their expressive goals, they adopt their own perspective of the piece.
Procedural Learning	4	I record myself in a video or audio playing a piece so as to give my students a clear model of how they have to do it.	4	I ask them to compose, improvise or transform a known piece of music and then they explain how they have done that.
Attitudinal Learning	4	I encourage my students to get into the habit of following prefixed timetables for class and for carrying out activities.	4	I dedicate time to us jointly assessing and deciding how to manage the class and virtual activities.
Assessment	4	I promote competitions among my students to find out who plays better (more in tune, with better sound, etcetera.).	4	I ask them to listen to one another so as to assess what their colleagues have done and to suggest possible improvements.
Cooperation	0		4	I suggest creative activities to them to work in a group (harmonising a melody, composing music for a video, etc.), and I ask them to explain how they have organized themselves and how they have jointly resolved their difficulties.

*N is the number of questions dedicated to this category throughout the entire questionnaire.

Table 2. Sample and variable characteristics.

Variable	Categories	Number of category[1]
Gender	Man	103
	Woman	140
Experience	Between 0 and 10 years	55
	Between 11 and 20 years	74
	Over 21 years	114
Stage	Initiation and elementary	80
	Pre-professional training	111
	Advanced	52
Instrument	Woodwind	69
	Brass	34
	Guitar/plucked string	19
	Bowed string	53
	Piano/keyboard	55
Music teaching speciality	Interpretation (music performance)	203
	Pedagogy (music education)	30
Prior use	Never	69
	On occasion	139
	Almost always or always	35
Digital resources available to the students	A few	25
	Almost all	97
	All	121

6.3. Analyses

A reliability analysis was carried out using Cronbach's alpha to ensure the consistency of the overall survey (.89), and each of its subscales. Alphas for the learning approaches (Reproductive and Constructivist) were above .75, and the remainder were above .60.

The mean frequency of each item was estimated. All the demographic variables were treated as categorical. Objectives 1, 2, and 3 were analysed with Analyses of Variance (ANOVAs) of one and two factors of repeated measurements, or completely randomised, depending on the data structure. The ANOVAs of a completely randomised factor were complemented with a post hoc analysis, to which the Tukey correction was applied, and the Bonferroni correction was applied to the two factor ANOVAs. Three teacher profiles were identified from a cluster analysis that linked them with the demographic variables using the statistic χ^2 and its corresponding Corrected Typified Residuals (CTR). Lastly, ANOVAs were carried out in which the differences between the profiles were identified according to each of the dimensions involved. All statistical analyses were performed using SPSS software (version 26).

7. Results

7.1. Activities using ICT

The first objective was to find out how often teachers provided activities for their students using ICT. The first data, already included in Table 2 is that 49.8% of teachers indicated that all their students had the necessary ICT resources for virtual learning while 39.9% indicated that almost all had them. Only 10.3% recognized some difficulty in this regard since only some students had these adequate

digital resourcesOn average, they reported providing them midway between *occasionally* and *on more than one occasion* ($M = 2.62$, $SD = 0.46$).[1] ANOVA revealed a significant effect of instrument, such that brass instrument teachers provided more activities than bowed string and piano teachers ($p < .01$), and a significant effect of educational level, such that fewer ICT activities were provided by teachers of students at the elementary level than teachers of pre-professional students ($p < .001$). Teachers who had previously used ICT on either *on one occasion* or *often* provided more ICT activities during lockdown than those who had never used them ($p < .01$). The remaining variables (gender, speciality, teaching experience, and digital resources available during the pandemic lockdown) had no significant effects on how often activities using ICT were provided.

Beyond determining ICT usage frequency, one of the essential proposals of this study (Objective 2) was to confirm whether these activities were aimed more at reproductive or constructive learning. As shown by the analysis of these data, teachers carried out significantly more reproductive activities ($M = 2.92$, $SD = .47$) than constructive ($M = 2.40$, $SD = .56$) ($F = 279.48$, $p < .001$, $\eta_p^2 = .54$). Apart from being a considerable effect size—the largest found in this study—the difference between both types of activities was significant for all of the study variables ($p < .001$). We can therefore affirm that all groups, regardless of the variable studied, on average employed more activities aimed at reproductive rather than constructive learning during the lockdown.

However, within this global pattern, post hoc analysis revealed several differences between the values of these variables. Although no impact was observed that was associated with choice of instrument, speciality, level of experience, or the resources available to students, there were differences in terms of gender, since men pursued more constructive activities than women ($p < .05$), although the frequency of reproductive activities was the same in both cases. We also found that more reproductive activities took place in pre-professional training

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[1] The frequencies correspond to the activities that the teachers *stated* they employed. However, to facilitate the reading of the text, we will refer to them simply as the activities that the teachers employed.

education than in elementary education ($p < .01$) or in higher education ($p < .001$), whilst in both pre-professional training and in higher education more constructive activities were performed than in elementary education ($p < .05$). Previous use of ICT had an impact on the frequency of constructive activities, which were carried out more often by teachers who used ICT frequently before the lockdown, or even occasionally, than by those who had never used it ($p < .01$). In contrast, the previous use of ICT had no impact on the frequency of reproductive activities, which was the same in all cases.

The third study objective was focused on analysing the frequency with which the activities were aimed at different types of learning (verbal, procedural, attitudinal), the type of assessment carried out, and the social organisation of these activities. As shown in Figure 1, there is a pattern where the intended activities were aimed significantly more at promoting verbal than procedural learning, and more procedural than attitudinal ($F = 21.01$, $p < .001$, $\eta_p^2 = .08$). As may also be seen in Figure 1, the assessment activities were fairly frequent, while the cooperative activities were only occasional and only employed once ($M = 2.06$, $SD = .76$). All of the differences between the study dimensions are statistically significant ($p < .001$), except for that between procedural and assessment learning.

These results were again minimally affected by the variables studied (see Table 3). Once more there were no differences due to gender, speciality, instrument, or teaching experience. The observed differences mostly relate to educational level. Post hoc analysis showed that elementary level teachers employed fewer verbal learning activities than teachers of pre-professional and higher levels ($p < .01$). However, teachers of pre-professional levels undertook more procedural activities than those of elementary and higher levels ($p < .05$), and more attitudinal activities than those of higher levels ($p < .01$). Again, the chosen instrument also had an impact. Before, we saw that brass instrument teachers were the most active, but it now became apparent that they employed more procedural learning activities than those of bowed string or piano instruments ($p < .01$), but also more attitudinal than those of bowed string ($p < .05$), and they assessed their students more frequently than those of woodwind, bowed string, or piano ($p < .05$). Finally, teachers who were used to using ICT frequently before the pandemic employed more procedural, assessment, and cooperation activities than those who had never used them, or had only used them on occasion ($p < .01$), and more attitudinal activities than those who had never used them ($p < .01$); in contrast, activities aimed at verbal learning were equally frequent in all groups.

There were no differences in assessment types (reproductive/constructive) associated with these variables, but there were in cooperative activities, which are more frequent at the pre-professional level than at the elementary level. The availability or non-availability of digital resources for facilitating learning—a subject which has been much discussed in the media—hardly impacted activities. However, it is important to point out that teachers with fewer resources promoted the students' cooperation to a greater extent ($F = 2.89$, $\eta_p^2 = .02$).

To sum up, instrument teachers mostly employed activities aimed at promoting verbal learning and, to a lesser extent, procedural learning, and very few cooperative activities. Pre-professional teachers proposed the most varied activities. It should also be remembered that these activities were more often aimed at promoting reproductive than constructive learning, as was previously noted, and this observation is supported by the fact that both conclusions were statistically significant ($p < .001$).

The last objective was to identify the teaching profiles associated with ICT usage in instrument classes. To do this, we performed a cluster analysis wherein three distinctive profiles were observed, according to the amount of activity ($F = 500.83$, $p < .001$, $\eta_p^2 = .81$) and the differences in frequency between reproductive and constructive activities ($F = 19.74$, $p < .001$, $\eta_p^2 = .14$) (see Figures 2 and 3).

The first profile, *Reproductive Passive*, to which 47 teachers belonged, was the least frequent, and was characterized by very low levels of activity ($M = 1.99$, $SD = .23$), almost exclusively of the reproductive type, as shown by the comparison between the means of the two types of activities ($MD = .61$, $p < .001$). The second profile, *Reproductive Active*, to which 105 teachers belonged, was the most numerous, and carried out more activities than the previous profile ($M = 2.50$, $SD = .15$). However, the overall pattern is the same, since, as can be seen in Figure 3, their tendencies are highly similar and their activities continue to emphasize the reproductive conception ($MD = .68$, $p < .001$). The third profile, to which 91 teachers belonged, carried out the most activities ($M = 3.10$, $SD = .234$), and was also the profile with the smallest differences between the frequency of its constructive and reproductive activities, although the latter continued to be predominant in this group as it had for the others ($MD = .287$, $p < .001$). Due to this greater balance between, or diversity in, its activities, and in keeping with the conceptions described in the introduction, we have called this profile *Interpretative*.

Figure 4 provides a more detailed characterisation of these three teaching profiles, according to the activities performed in each dimension. After the post hoc analyses, all differences between the three profiles in each of the dimensions were significant to the level of $p < .001$, except between the active and passive reproductive profiles in cooperative activities, where differences were smaller ($p < .05$). In other words, the three profiles were clearly differentiated in the amount of ICT usage. The teachers assigned to the interpretative profile carried out more activities of all types than those in the active reproductive profile, and they, in turn, carried out more than the passive reproductive teachers.

However, within each profile, we found there were certain patterns that were differentiated. Thus, the passive reproductive group carried out significantly more activities in all of the reproductive dimensions than constructive dimensions ($p < .05$), with the exception of constructive verbal activities, which presented the same frequency as the reproductive dimensions and therefore were more common than the other constructive activities ($p < .05$).

In the active reproductive profile, all of the differences between the reproductive and constructive dimensions were significantly in favour of
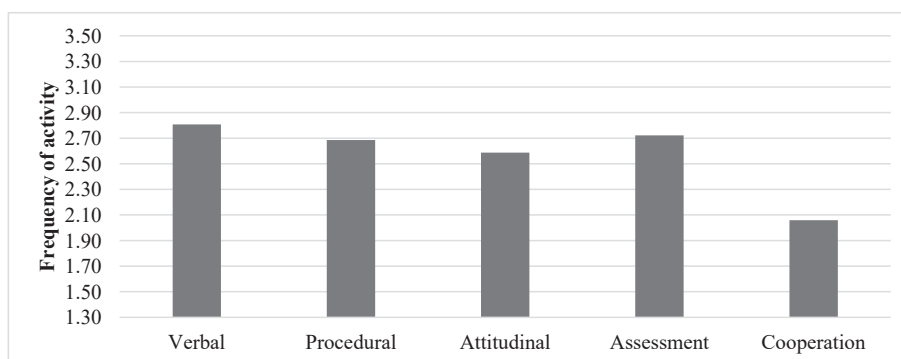

Figure 1. Mean of analysis dimensions.

Table 3. Influence of different variables in the frequency of usage of each dimension according to the ANOVA of a factor.

	Verbal learning		Procedural learning		Attitudinal learning		Assessment		Cooperation	
	F	η_p^2	F	η_p^2	F	η_p^2	F	η_p^2	F	η_p^2
Gender	0.41	.01	0.58	.01	0.24	.01	2.89	.01	3.12	.01
Teaching experience	1.59	.01	1.93	.02	1.87	.02	0.58	.01	1.50	.01
Educational level	17.86***	.13	6.44**	.05	4.85**	.04	7.40***	.06	3.98*	.03
Instrument	0.50	.01	5.92***	.10	3.65**	.06	7.09***	.11	2.69*	.05
Speciality	0.06	.01	0.38	.01	1.92	.01	1,02	.01	1.87	.01
Previous ICT use	2.83	.02	6.62**	.05	5.65*	.05	7.37***	.06	7.18***	.06
Available resources	0.05	.01	0.22	.01	0.71	.01	0.08	.01	2.89*	.02
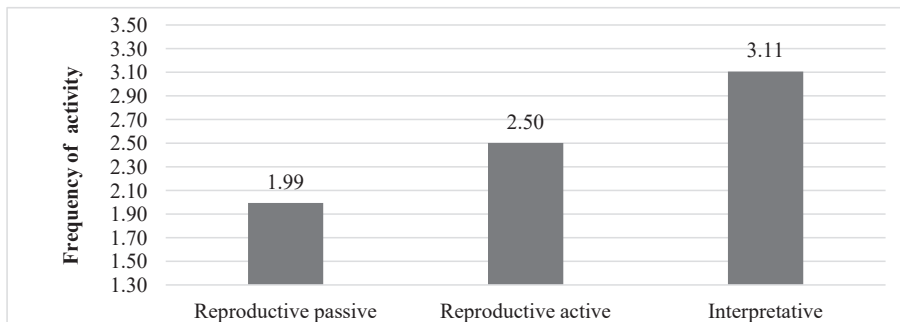
Figure 2. Amount of activities in keeping with the different profiles.
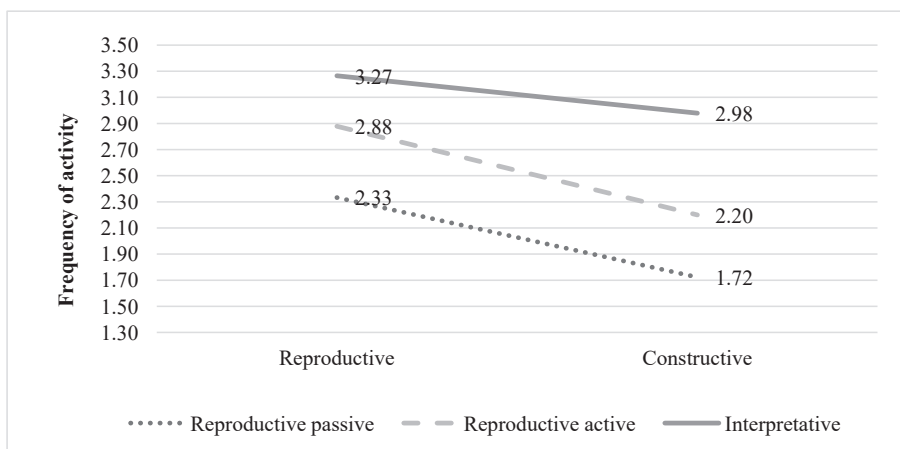
Figure 3. Type of activity performed according to the different profiles.
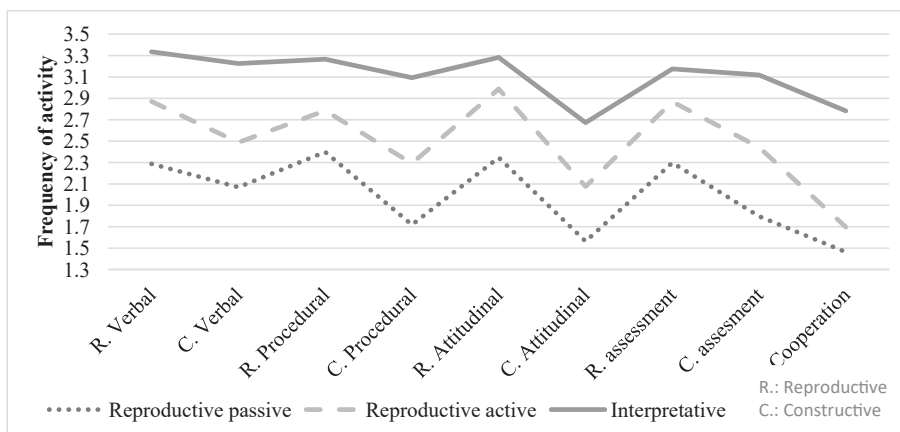
Figure 4. Frequency of each type of outcome in the profiles.

the former ($p < .001$). Within the constructive activities, the least frequent were the attitudinal ones, and those referring to cooperation ($p < .05$). The cooperative activities were less frequent than those of constructive attitudinal learning ($p < .001$). Those teachers who usually used constructive activities were particularly reluctant to use them when this implied fostering values and cooperation.

The interpretative profile, despite having the smallest differences in frequency between its reproductive and constructive activities in verbal, procedural, or assessment tasks, nevertheless employed far fewer attitudinal and cooperation constructive activities than any other type ($p < .001$). It is also interesting that there were no differences in this group between the constructive verbal and reproductive. This is the only group and the only dimension where these differences do not appear. Interpretative teachers employed more varied activities than the other types of teachers, and made particular use of constructive activities for verbal learning, but employed far fewer constructive activities linked to changing attitudes or cooperation.

In addition to analysing these differences between profiles in their use of activities, we were also interested in exploring which types of teachers tended to favour particular profiles. Using χ^2 tests, we were able to confirm that the profiles were not related to gender, speciality, education level, years of teaching experience, or available ICT resources during the lockdown. Links were found to the chosen instrument ($\chi^2 = 18.86$, $p < .05$), and particularly to previous experience with ICT ($\chi^2 = 16.54$, $p < .01$). More specifically, with regards to the type of instrument taught, the residual analysis showed that for the passive reproductive profile there were fewer brass instrument teachers than expected ($CTR = -2.2$, 5.9%)[2], but on the other hand they were over-represented in the interpretative profile ($CTR = 2.8$, 58.8%). As far as we were able to observe, these teachers were more active in general and also made use of more varied activities. In addition, there were more piano teachers than expected in the active reproductive profile ($CTR = 2.0$, 54.5%), and fewer than expected in the interpretative profile ($CTR = -2.1$, 25.5%).

The single variable most strongly associated with these profiles was the frequency of usage of ICT prior to the pandemic. Those who used ICT more were under-represented in the passive reproductive profile ($CTR = -2.2$, 5.7%) and over-represented in the interpretative group ($CTR = 3.0$, 60%), where there were few teachers who had never previously used ICT ($CTR = -3.2$, 21.7%). In other words, the greater the previous use of ICT, the more it was used during the lockdown, and in a more varied and complex manner.

8. Conclusions and discussion

Our intention in this study was to analyse the use that instrument teachers had made of ICT during the months of educational lockdown caused by the COVID-19 pandemic, with particular regard to both quantitative (frequency of activities) and qualitative aspects. Our first conclusion is that teachers only sporadically performed these activities. However, in this study most teachers reported that almost all of their students had the necessary technological resources available to them.

Aside from determining this overall frequency of activity, we were primarily interested in our second study objective, which was whether this use was based more on reproductive (teacher-centred) learning activities or on constructive (student-centred) activities. The results show that teachers performed significantly more reproductive than constructive learning activities. There was also a considerable, highly robust, and consistent effect size (effect size = .54) running through all the variables analysed in this study. We may therefore state that instrumental teachers design activities where they themselves can control the ICT usage, instead of proposing activities where their students can seek, select, or control either the process or the information (Ertmer et al., 2015). Most

of the activities seem to have been limited to presenting students with an explanation to serve as a model for their practice.

On the one hand, our data set contrasts with that obtained by Biasutti et al. (2021), who observed innovative or transformative use of ICT during lockdown, possibly due to the fact that they workd with a small and non-representative sample. Moreover, we asked teachers to identify the actual frequency of their practices rather than to provide only their beliefs and preferences. Indeed, our findings coincide with several previous research studies on instrumental or musical teaching conducted before the pandemic (e.g., Cano et al., 2014; Chao-Fernandez et al., 2017) that showed also a teacher-centred use of ICT. They also coincide with studies carried out during the COVID-19 lockdown in other educational fields, such as those on ICT practices in primary and secondary education (Pozo et al., 2021). In one sense, the education processes employed during the COVID-19 lockdown served to reinforce previous teaching conceptions, which were essentially centred on the transmission of content rather than the development of individual competences in music students. Thus, one of the educational implications of this study is the need to foster a conceptual change in teachers' conceptions (Pozo et al., in press) towards more constructive beliefs, focused on the students' ability to learn in a self-regulated and autonomous manner.

Regarding our third objective, we found that the activities employed by the teachers were primarily focused on symbolic or verbal learning, and to a lesser extent procedural learning, and most often utilized reproductive objectives. The activities focused on attitudinal learning were almost exclusively reduced to reproductive conceptions linked to the fulfilment of norms, and almost never to generating individual reflection or managing students' emotions. The least frequent activities were those aimed at fostering cooperation between students. It appears that even today instrumental learning is conceived of as focusing on the technical mastery of the musical score and the instrument, in keeping with the traditional "conservatory" model (Jørgensen, 2000) of individual learning based on teacher-centred activities. In fact, cooperative activities were the least common of all the types of activities, despite the fact that later in their careers most musicians will play in group contexts (Casas-Mas et al., 2015) and will need to learn this social skill in order to function as professionals, even if it does not appear to form a crucial part of their formal musical education (López-Íñiguez and Bennett, 2020).

Although this aforementioned pattern seems to apply to most of the teachers in the study, our fourth objective was to identify possible profiles or teaching styles in ICT usage. Cluster analysis identified three profiles. Two of them, which accounted for almost two-thirds of the teachers, were characterized by almost exclusively carrying out reproductive learning activities, although in one case with a very low level of activity (passive reproductive profile) and in another with a higher level of activity (active reproductive). However, there is a third profile (which we call interpretative) that, although likewise using more reproductive activities, also makes frequent use of constructive activities, with a smaller difference in frequency between the two types of activities than the other profiles. This profile, therefore, makes more balanced use of ICT, and includes different types of activities, with the exception again of activities aimed at attitudinal constructive learning and cooperation, which are also rare among these teachers.

It is interesting to note that, even among interpretative teachers, the dimension of constructive learning that is most emphasized is verbal learning, which is also a dominant aspect of the other two profiles. Once again we have confirmed that instrumental learning is primarily focused on the mastery of the score, particularly at a verbal level, and even in detriment to procedural learning, which should be so central to instrumental teaching and is particularly supported by metacognitive management (e.g., Hallam, 2001; Hallam et al., 2012); In addition to analysing the differences between these profiles, we also studied how the teacher variables are associated with the different teacher profiles. Teachers who had made greater use of ICT in the classroom prior to the pandemic formed the majority of the interpretative profile, which was the most complex teaching conceptions identified in this study. In fact, it

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[2] This refers to the percentage of a category that is distributed among the different profiles.

may be said that the higher the previous use of ICT, the more activities were performed during the pandemic, and the greater was their complexity. This outcome is similar to that obtained in other fields (Pozo et al., 2021). This variable seems to have the highest influence on the various results obtained in this study, since it predicts a higher general use of ICT, a higher use of constructive activities, and a greater variety of employed activities.

In contrast to the notable effects of this variable on ICT usage, other variables had almost no impact whatsoever. Hardly any effects associated with teaching experience were observed—unlike other studies on teaching conceptions in the field of music (Bautista et al., 2010; López-Íñiguez et al., 2014) —which paradoxically indicated that the newest teachers were the ones with the most complex conceptions. Possibly the fact that this study focused on the practices declared by the teachers and not on their conceptions or explicit beliefs on what is desirable (Ertmer et al., 2015), may explain this difference. It remains a concern, however, given that the youngest generations should have greater practice and knowledge of digital tools.

We observed no notable effects associated with gender or the available digital resources for students during the pandemic. Very often, and particularly in the media, the lack of student resources is used as an explanation for low ICT usage. However, in this study we found that ICT usage limitations were not linked to available resources—what Ertmer (1999) called "First-order barriers"—but rather to teaching implicit conceptions, beliefs and habits, the "Second-order barriers".

It is also striking that the teaching speciality (which differentiated between interpretation teachers and music education specialists) had no effect on ICT usage. It appears that teachers of music education do not promote more complex or elaborated practices than other types of teachers.

We also observed several differences associated with the educational levels of the teachers. In general, teachers of elementary levels undertook fewer activities than the others, and the activities they did employ were directed towards reproductive learning: the fact that fewer activities were performed during the lockdown with the youngest children has also been confirmed in other educational contexts (Pozo et al., 2021), and could be linked to the children's lower autonomy in the use of digital technologies, despite being from Generation Z and supposedly finding it easier to navigate them. Further study of how the use of these tools is promoted in children is needed here. However, the fact that the few activities performed were directed at reproductive aspects, to a greater degree than those of other teachers, may be connected to specific teaching conceptions that dictate that it is first necessary to accumulate directly transferred musical knowledge in order to pass onto the next stage of learning (Bonastre et al., 2017; Pozo et al., in press).

The findings from the study showed that the activities undertaken at music schools and conservatories during the pandemic lockdown were primarily directed at the musicians' technical training, fostering their mastery of the musical score and the instrument, and remained distanced from the demands of what should constitute a complex and student-centred 21st-century musical education (Pozo et al., in press). Since the teachers who made more frequent and complex use of ICT during the COVID-19 crisis were those who had the most experience with them prior to it, the promotion of ICT usage spaces appears to be an urgent issue. This should also be accompanied by teacher training that promotes reflection and constructive learning for the teachers, since it seems that the activities aimed at musical education remain, at least in the context of this study, focused on traditional teacher-centred approaches instead of student-centred ones.

To conclude, compared with the multiple potential benefits of ICT in musical training mentioned in the introduction (increased creativity, regulated learning, communication, and a more global learning perspective; see Boucher et al., 2019), the practices utilized during the critical incident of the COVID-19 pandemic have been limited to repeating and even simplifying traditional conceptions in which the teacher conveys knowledge to the student so that the student may reproduce or imitate it. It appears that this critical incident has failed to act as an impetus to reconstruct practices, as was hoped in the introduction (e.g., Butterfield et al., 2005; Monereo, 2010). However, we still have time to use data such as that in this study to encourage reflection on teaching practices (Schön, 1982; Ozer and Ustün, 2020), thus helping to transform them so that they can employ ICT to actually place the students at the centre of instrumental training, as modern times demand.

Declarations

Author contribution statement

Juan Ignacio Pozo, Maria Puy Perez-Echeverría, Amalia Casas-Mas and Guadalupe López-Iñiguez: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Beatriz Cabellos: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Elisa Méndez, Jose Antonio Torrado and Lucas Baño: Conceived and designed the experiments; Analyzed and interpreted the data.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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