International Journal of Technology Enhanced Learning

ISSN online: 1753-5263 - ISSN print: 1753-5255
https://www.inderscience.com/ijtel

ICT complement for supporting flute study at home

Paloma Bravo, Iván González, José Bravo

DOI: 10.1504/IJTEL.2022.10049447

Article History:

Received:	17 July 2021
Last revised:	19 November 2021
Accepted:	19 November 2021
Published online:	22 December 2022

ICT complement for supporting flute study at home

Paloma Bravo

Colegio Público Vicente Aleixandre,
San Antonio s/n,
Marbella 29601, Spain
Email: paloma.bravo.fuentes@gmail.com

Iván González and José Bravo*

MAmI Research Lab,
Castilla-La Mancha University,
Paseo de la Universidad,
Ciudad Real 13071, Castilla-La Mancha, Spain
Email: ivan.gdiaz@uclm.es
Email: jose.bravo@uclm.es
*Corresponding author

Abstract: Many countries propose flute studies in primary school. Usually, students have only one class per week, which makes it inconvenient for teachers to pay attention to students individually. Another problem is that, after lessons, students have to practice alone at home. Thus, the responsibility for progress lies almost entirely with the learner. This paper proposes a digital tool as a complement to alleviate both problems. The app provides a listening tool, music scores view, records learner performances and offers feedback about students' mistakes during their performances. Finally, the student evolution is sent to the teacher in an adequate manner, to achieve more effective teaching in each class.

Keywords: music education; ICT methodology for learning flute; melodic similarity.

Reference to this paper should be made as follows: Bravo, P., González, I. and Bravo, J. (2023) 'ICT complement for supporting flute study at home', *Int. J. Technology Enhanced Learning*, Vol. 15, No. 1, pp.40–57.

Biographical notes: Paloma Bravo (PhD) is a Teacher at Primary School in Marbella (Spain). Degree in Classical Guitar from the Music High Conservatoire of Córdoba, Spain, Master's degree in Educational Technology: E-learning and Knowledge Management. Her research interests include music education & technologies applied at primary school.

Iván González (PhD) is an Assistant Professor at Castilla-La Mancha University and Member of the MAmI Research Lab. His research interests include ambient assisted living, AAL, gait analysis, m-health and computers & education.

José Bravo (PhD) is a Full Professor and Head of the MAmI Research Lab at Castilla-La Mancha University. His research interests include ubiquitous computing, ambient intelligence, AAL, m-health and computers & education.

1 Introduction

In our view, music in primary school is a subject that could be complemented by the use of ICT. Basically, students have only 45 minutes or one hour of music per week organised by group lessons. This group is also very large, with a minimum of 25 students per class. These reasons are clear drawbacks when it comes to accomplishing the teaching and learning process of the students, as it is very difficult to pay attention to them individually.

Furthermore, learning to play an instrument is difficult with the current methods. This work proposes a methodology and a digital tool to complement learning to play the flute constructively and guided by the metaphor of the virtual teacher.

In practice, the responsibility for studying at home lies with the student. That is, students have come to decisions about the desirable level of the pieces to be performed. The evolutionary and educational psychology marks the importance of different levels of learning within the students, and the music education teacher must keep this in mind and give answers at all levels. This becomes practically impossible to achieve due to the combination of the high number of students of different levels, in a group class and during one hour per week.

Flute teaching in primary schools is based on the use of traditional methods and songs, usually far from the interests of students, who lose motivation because of the difficulties in studying the instrument alone at home.

With all this, we strongly believe it is necessary to propose an ICT solution to complement the study of the flute so students can improve their instrumental practice and enjoy their learning without becoming frustrated. This helps students at home during the learning process in the traditional way proposed in the literature, and it provides feedback to teachers after the students' practices. With this, teachers have a better understanding of the students' development with the information provided by the use of ICT. Moreover, the teacher can start from the beginning of the music lesson knowing exactly which mistakes are made by the students from an individual, small group and whole/large group point of view. Therefore, no time is wasted in detecting mistakes during the lesson, thus optimising time.

1.1 Literature review

Nowadays, many approaches incorporate the use of ICT to improve music learning at all levels and from a theoretical and/or performance point of view. In Willems (1981), the authors propose a series of tutorials on music education-related aspects such as notation, rhythm, tempo, etc. However, this approach is only a passive learning tutorial; there is no feedback from a specialist teacher in the subject.

In Esquivel (2009), the methodology of music educator Carl Orff (from the movement known 'Escuela Nueva') goes beyond the use of ICT in the classroom, as it promotes the active participation of the students during music lessons. In these approaches, the main objective to be followed is to carry out a pedagogical strategy for learning and teaching music in which vocal exercises, the use of simple musical instruments (flutes, drums, xylophones, etc.), together with percussion and body expression, allow students to feel music as a real and living experience, instead of focusing only on music theory. In this regard, it is interesting to note that ICT tools can be perfectly suited to support Orff's strategy in the classroom. However, these

methodologies do not consider the possibility of students continuing their learning outside the classroom at any time, i.e. from home, something which is necessary to improve performance with a musical instrument.

Regarding the study of a specific musical instrument by the learner, Jambrina (2017) proposed the use of very simple graphics whose purpose is to help students progress in the practice and performance of a particular instrument in a simple way.

Focusing specifically on the study of the flute, numerous educational songbooks (Escudero, 1990, 1992; Hidalgo, 1994; Videla, 1980) are available, based on different methods of musical interpretation of small pieces or even fragments/passages sorted by increasing technical and musical performance difficulty. This progressive difficulty makes the students acquire technical and interpretative knowledge little by little. It is interesting to note that none of these methods offers students auditory or visual support different from the stave. The latter is the main limitation of traditional educational songbooks in learning a musical instrument. If students present difficulties when playing the stave, they will still have them as they advance in their learning with the instrument.

Linking the world of music education with ICT, numerous authors are noted for incorporating ICT into music education classrooms, for example, McDowall (2009), who has actively collaborated with primary school teachers. In her research, students have used a range of computer-based music technologies, with particular emphasis on applications that encourage musical creativity. Other work, Reynolds (2005) used qualitative analysis techniques, including interviews with teachers and children, direct observation and analysis of children's musical compositions. Reynolds' research concludes that students have participated in relatively sophisticated musical creative processes that would not have been possible using conventional musical resources (Sloboda, 2010).

Thanks to the resources provided by ICT and, in particular, incorporating the virtual teacher metaphor, we intend to eliminate these limitations, provide more autonomy to students at home in learning the instrument, turning that part of study into a fundamental process within learning. Thanks to ICT, students can listen to a reference performance (considered well-played) of a fragment or musical passage under study. Then they can try to reproduce it using the recording function that will be integrated into the mobile application. At this point, students will receive automated feedback regarding the mistakes made and points to be improved. In addition, teachers will receive individual feedback from each student and group feedback to reorganise the time and procedure so the class can be aware, from the beginning of the lesson, of the mistakes the students are making and be able to address them directly, producing an optimisation of time that represents an immediate improvement of the teaching-learning process.

As far as we know, there is no proposal based on the development of a mobile digital application that supports flute learning considering aspects such as i) the metaphor of the virtual teacher and ii) the continuous evaluation of students thanks to the feedback provided for both students and teacher. In this sense, we have found only one contribution that uses melodic similarity measures for automatic scoring of the singing voice (Sloboda, 2010). In this work, the feedback is returned after comparing the user's performance and a reference melody. To some extent, this can be considered a partial application of the virtual teacher metaphor, as it provides mechanisms for finding differences between performances and explicitly guides the user through these dissimilarities.

1.2 Time and practice

Sloboda defends the idea that students' expressive and technical skills are proportional to the hours of practice with the instrument (Sloboda, 2010). In other words, the greater the number of hours spent, the greater the technical and interpretative results achieved. However, it is logical that the study time of primary school students cannot be counted in number of hours since their attention span is not so great. The studies of Kageyama (2013) and instrumental performance psychologists Hallam (1995) stated that daily practice time in children should not exceed 20 minutes a day, recommending short study time more frequently.

On the other hand, it is interesting that not all the time devoted to studying the flute should necessarily be with the instrument in one's hands. It is very convenient for the students to do listening exercises and follow the score they are going to learn.

In these study intervals, students should perform a conscious practice in which repetition helps improve performance, makes mistakes disappear and does not create a persistent mistake that is much more difficult to correct. In this context, Kageyama (2013) discussed in detail why an unconscious form of study is the least recommended way to approach the practice of a musical instrument for a number of reasons:

1.2.1 Time is not optimised

By practicing in this way, students get little productive learning, i.e., the improvements are not really tangible. Moreover, bad habits, mistakes and vices are entrenched, which are difficult to correct later.

1.2.2 Loss of confidence

Without a doubt, the fact that students fail to make progress in the study of an instrument makes them less confident, as they do not achieve the objectives proposed at the beginning of the workday.

It is clear that primary school students will not play in an excellent manner from the first day of studying a musical piece for the flute. However, repetitions made in a conscious way (focusing on those fragments or musical passages that cause the most difficulties) will help them reinforce good habits until they are stronger than the bad ones. This will also help the students gain confidence.

1.2.3 Danger of boredom

It is important to emphasise that repeating without improvement in each repetition due to not having proper feedback leads to frustration and can result in a bored and unmotivated student. In the main pedagogical methodologies of the 20th century, under the name '*Escuela Nueva*', the constant importance of students' motivation is highlighted as an essential methodological principle to achieve their maximum active participation in their own learning process.

For these reasons, models of learning the instrument that do not provide adapted and customised feedback must be avoided since a decline in students' motivation may be due to a poor optimisation of study time (filling their practice with repeated unknown mistakes and, therefore, vices that are difficult to correct afterwards), a loss of self-confidence or a fall into boredom.

The relationship between instrumental practice and motivation can often be found in the mediating role of the teacher. According to Hallam (1995), students should be exposed to different musical styles in a free manner, and when possible, close to their interests and environment to achieve a positive emotional response to music. For this reason, music education teachers must have numerous resources and be constantly renewing themselves. In the same vein, motivation is one of the basic elements of a learning process, so teachers need to know the student's interests to understand what moves them to act and, in this way, be able to help them in their self-regulation.

Learning based on student motivation automatically becomes, without effort on the part of the students, significant learning for them. For this reason, the resources and strategies used to encourage this type of learning are useful inside and outside the music education classroom.

2 Research design and research questions

A research design is a framework created to find answers to research questions by performing a deductive method to reach concrete conclusions and create solutions. In this way, the following research questions arise on which this work is developed.

Is one hour a week of lessons enough time to learn to play an instrument?

One group lesson per week is insufficient to learn a musical instrument since authors Molina (2012) define instrumental practice as a constant and systematic rehearsal for learning acquisition. With this amount of time, it is not possible to achieve constancy and systematisation.

For Sloboda (2000), developing the technical and interpretative skills of the instrument is directly proportional to the time spent studying it. In this way, the motor skills necessary for interpretation are acquired, which require time and constant practice (Forcada, 2008).

In concluding that one hour a week of instrumental practice is insufficient, Byo and Cassidy (2008); Jorgensen (2000) and Oare (2012) stated that pupils do most of their instrument study autonomously outside the educational environment.

Does the primary school child have sufficient autonomy to study the instrument outside of school?

School-age pupils need the help of the music education teacher to successfully complete the teaching-learning process of the instrument. Instrumental practice requires objective feedback that helps students consolidate their knowledge and not create motor vices that are difficult to correct. The music education teacher should therefore not be a mere transmitter of knowledge but a guide throughout the learning process of the recorder.

Do students lose motivation for the musical instrument?

In many cases, there are students who begin their recorder studies with enthusiasm but hate the recorder in the final year (of the recorder). It is a tangible loss of motivation that occurs when it should be the other way round, i.e. the more knowledge they have about the instrument, the more curiosity and desire they should have to learn.

This question needs to be studied since teachers should always encourage their students' motivation to learn. Boza and Toscano (2012) carried out a series of studies in which they deduced the presence of differences between motivated and unmotivated students. The former had expectations of success and the latter, on the contrary, of failure. For this reason, it is essential to know objectively whether students are motivated in the face of instrumental practice, and it is impossible to know this with the traditional teaching method.

Is it possible to know objectively whether students have stage fright?

When playing in public, not all students have the same predisposition. The pressure of the teacher performing their evaluation, being in front of the rest of their classmates, and even the silence preceding the musical performance can condition the pupils and expose their stage fright. This can provoke anxiety, which some authors call 'stage anxiety', defined as an experience that easily generates anguish in pupils, to the point of damaging what they have learnt (Salmon, 1990).

Sometimes the appearance of this anxiety is due to insufficient study time with the instrument, producing insecurity about the piece to be performed. If the class is in a large group and lasts only one hour a week, it is impossible to know the students well enough to understand whether their stage fright results from insufficient study time or another cause.

If students consolidate their practice and stage fright persists, there are different ways to overcome it, such as the one defined by Gregg et al. (2008), which consists of imagining oneself performing in front of an audience to avoid the emotional impact this entails on the day of the performance. Gabbard (1981) stated that this practice favours the performer's concentration with the traditional teaching method; it is very difficult to know what may cause the appearance of stage fright.

How can it be known whether the mistake made is one-off or recurrent?

In their study sessions, students can make two types of mistakes: one-off mistakes or recurrent mistakes. The former are made once during the study session, while recurrent errors are repeated during the same session.

It is important to know how to classify the errors in these two groups since it is not necessary to invest too much time in correcting a one-time error. However, it is necessary to dedicate time to correcting the recurring error before it passes into the muscular and auditory memory and becomes more complex to rectify.

The problem, once again, lies in the lack of time available for the teacher to monitor the students' study of the instrument, making it impossible to differentiate within the group class whether it is a question of one-off or recurrent errors, and in many cases dedicating class time to explanations of elements that are not so necessary.

To answer all the research questions, we incorporated technology into the flute teaching-learning process.

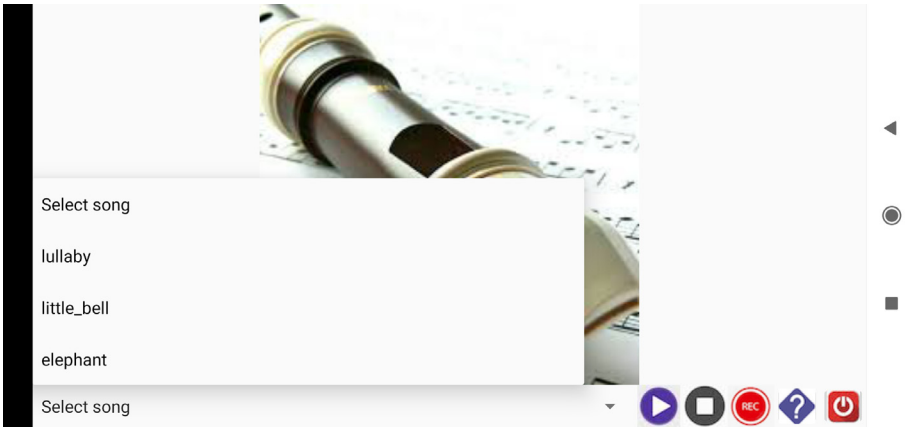
Regarding the teacher requirements to develop a technological complement for supporting the students' practice at home, a collaboration between them and computer scientists is necessary.

2.1 The student app (home)

Figure 1(a) shows the app presentation screen with some elements. On the bottom left and from left to right, we can see a spinner containing the list of songs selected by the teacher for each primary school level. By selecting the song to study (see Figure 1(b)), the student opens the score on the screen (see Figure 2(a)). In it, we can appreciate not only the musical language but also the flute graphs to help the students recognise the symbols in a simple and familiar manner.

Figure 1 (a) Presentation screen of the app and (b) selecting songs

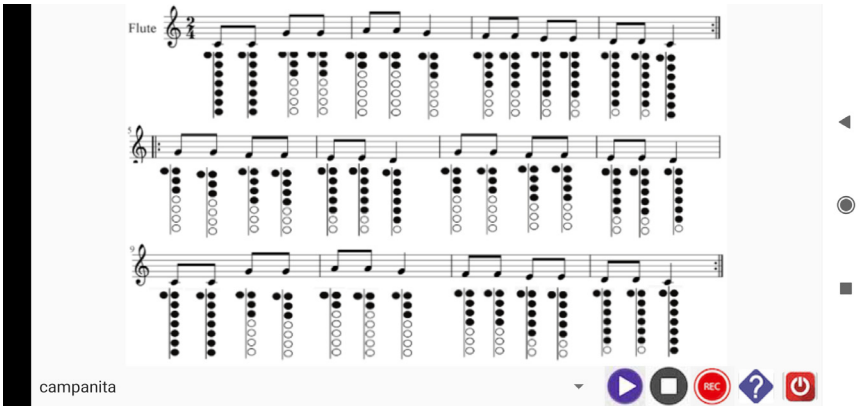
(a)



(b)

The next screen (see Figure 2(b)) presents a score video, one more time, to help introduce the musical language and song knowledge to students. This video is shown by a simple click on the button placed at the right of the spinner. With it, and changing the image of this button, the student can resume and play as many times as needed. Finally, the next button stops the video.

Figure 2 (a) Score and flute graphs and (b) score video

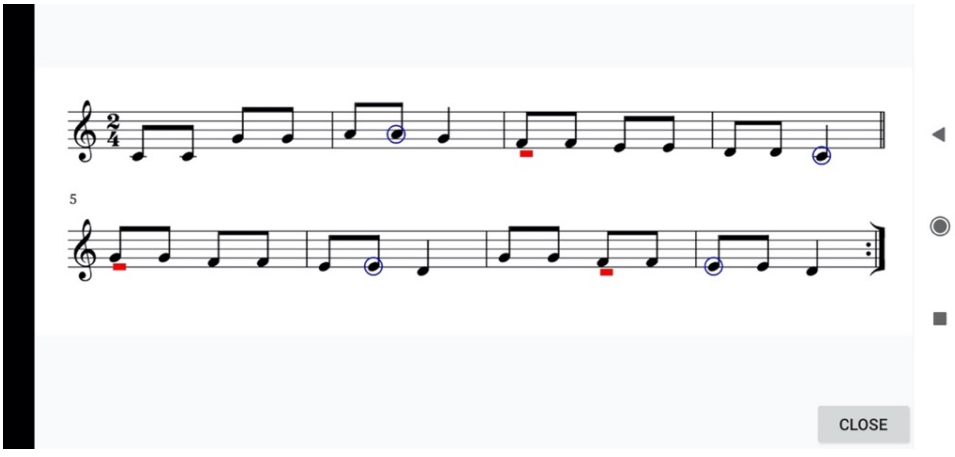


(a)

(b)

The Rec button (recording) allows students to record their performance of all or part of the song. After recording, the last screen (see Figure 3) in the app shows the mistakes during the performance. As you can see, the incorrect notes are pointed out with blue circles and the incorrect durations with red lines. This feedback will be sent, in a transparent and reduced manner, to the teacher. With it, the teacher can act in the classroom accordingly. This is the main goal of the methodological change in the flute music classroom for primary school. With the information collected by the app, it is possible to know how the study at home is progressing and be more effective in the classroom individually or in groups.

Figure 3 Performance mistakes



2.2 The teacher app (classroom)

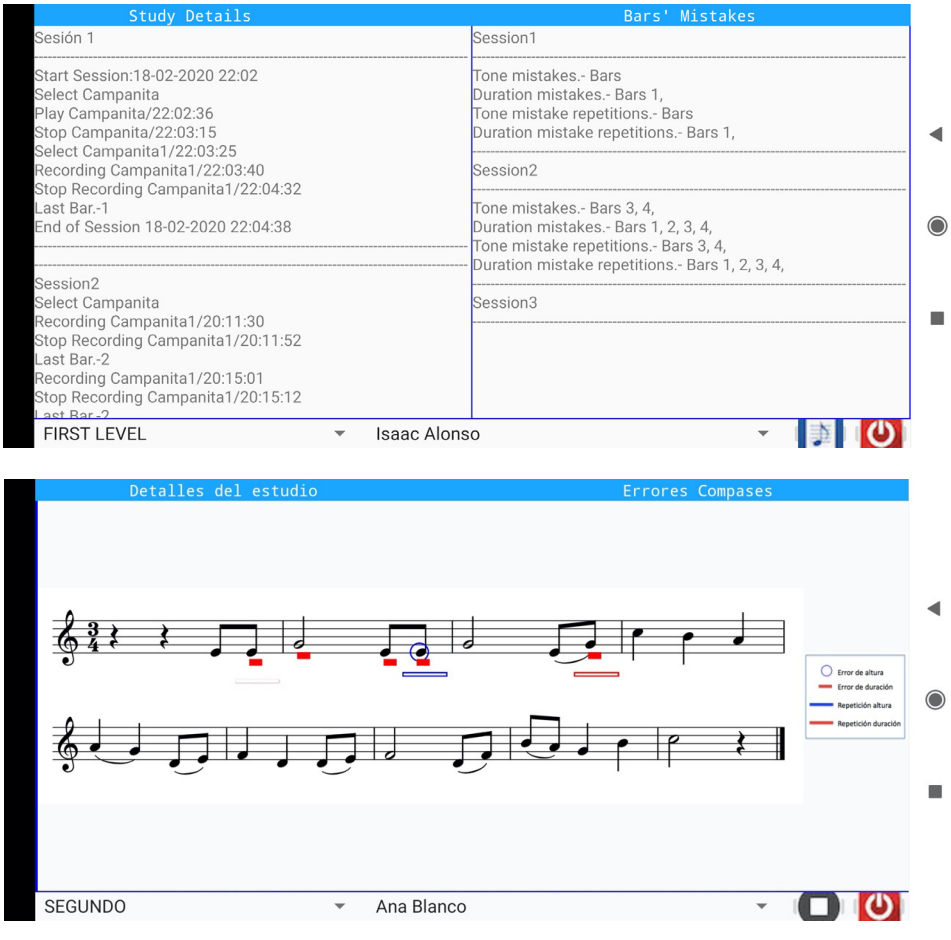
With the information provided by the app, the teacher has knowledge about how learners study at home. So, mistakes and repetitions of mistakes, incorrect practice and habits, etc., can be solved individually or within the group.

In addition to the direct help the tool offers students in their daily study of the instrument at home, teachers can also offer it thanks to the feedback they receive individually from each student and the entire class. This information allows teachers to work on mistakes the students are making in the performance of the piece without losing any time locating them. Therefore, the teaching and learning process potentially improves since the students at home do not lose time making repetitions full of errors and creating numerous vices that are difficult to correct later on. Then, in the classroom, teachers can focus directly on problems that have arisen in the study, which – without the information offered by the tool – would cost teachers even more if we think it would be ideal to know that information individually (something impossible in the one-hour session with the whole group).

The way teachers are presented with students' home study information is very important since we must remember that we are talking about individual cases, but within a group of students, because we have 25 to 28 students in the classroom. For this reason, teachers need to have the information, both individual and group, in a visual and simple way that quickly allows them to draw the necessary conclusions to get to work immediately and correct the mistakes with the students in the time of the music session.

Figure 4 shows the interface of the collected information of one student's study at home. In the top image, the information about each session is presented. On the left, the action performed during the study is presented. On the right, the mistakes of notes and duration while recording each song are shown. Below, a graphical mistakes representation showing mistakes of notes, duration and repetitions of mistakes can be seen.

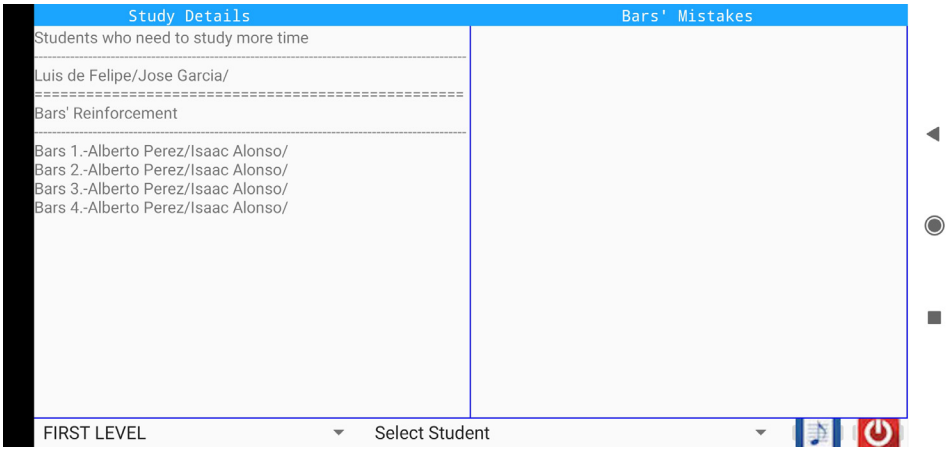
Figure 4 Student information by individual



The way in which the visualisation of this information is proposed is in a simple interface of a single screen. In it, in the upper part, as an essential element, the name of those students who have had special difficulties in their study will be highlighted, that is, those who have not completed any study days at home. Next, the information offered is grouped by students who have had difficulties in specific measures but without differentiating the type of error made. Thanks to this, we can go directly to a group of students who have had problems in that measure and solve it. At the same time, this teaching serves as a reinforcement for the rest of the group (see Figure 5)

In this section, it is interesting to mention that at times like this in the classroom, we will use the teacher's explanation methodology called peer tutoring, defined by Topping (2005) as the acquisition of knowledge and skills through active help and support of peers. It is mainly based on grouping the students in two (or small groups) in which one or one assumes the role of teacher and the other or the rest assume the role of students working towards a common goal set by the teacher (Duran and Vidal, 2004).

Figure 5 Group information



We can situate this methodology within the conceptual framework of 'learning by teaching', in which the format of interaction is bidirectional, totally removed from the idea of the teacher giving a masterclass. In this way, the student in the role of tutor learns by teaching, and the tutor learns thanks to his or her partner.

2.3 Technological relevant aspects of the developed ICT complement

The previous section focused on the different functionalities provided by the digital application developed as a complement to flute learning. This section will highlight some of the most relevant technical aspects required to undertake the previously described functionalities.

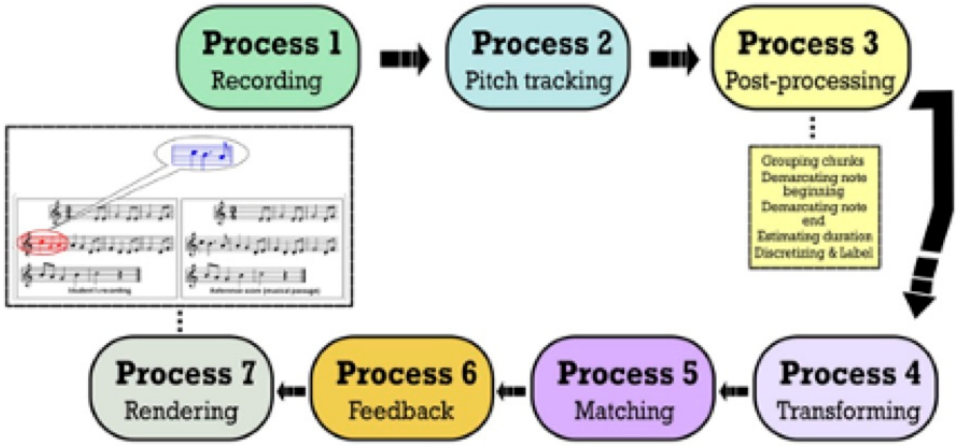
Specifically, we will focus on describing the techniques used to i) acquire the audio signal from the smartphone microphone that corresponds to a recording of an interpretation/performance, ii) carry out the corresponding pitch-tracking to estimate sound frequencies, and iii) identify and segment musical notes and silences and delimit their durations.

Identifying and labelling the musical notes the student plays with the flute during the recording of a musical passage is a must step to match the dissimilarities (mistakes) between the score of a musical passage (reference performance) and the score generated from the passage recorded by the student.

Before introducing the processing pipeline required to match dissimilarities and generate adequate feedback by the ICT complement, two types of mistakes can be distinguished according to their scope within the musical passage (local or global). The local ones are subcategorised as dissimilarities/mistakes with a single note scope, beat scope or musical phrasing scope and whether they affect a complete musical phrasing. For their part, global mistakes impact the full musical passage. The application we have developed focuses exclusively on the local mistakes, particularly identifying i) wrong notes (height mistakes) and ii) duration mistakes within a bar, as described in the last section.

The diagram in Figure 6 illustrates the processing pipeline to match dissimilarities and generate adequate feedback for the student and teacher. The main processes that will be described in detail in this section are process 2 (pitch-tracking) and subsequent process 3 (post-processing). Before discussing these processes in-depth, an overview of all the processes that make up the pipeline is provided.

Figure 6 All processes



When students play a flute passage at home, they can record their performance by using the Rec button as presented in the last section. This will activate the recording function in the smartphone application. Recording functionality has been implemented through a native android service running in the background, which makes use of the AudioRecord Java class, a pitch tracker algorithm named Specially Normalised Autocorrelation (SNAC) (Sloboda, 2000) and an XML-based, open-standard notation format named Music XML (Forcada, 2008).

3 Findings

The evaluation process of this computer tool in primary education shows that its use in musical education and, more specifically, in the study of the recorder as a musical instrument, improves the quality of the process of teaching students.

We can see that in the part that involves the student and corresponding to the teacher, the time invested is more effective since the application helps students in their study at home and the teacher in the preparation and optimisation of the class, which begins directly with the resolution of doubts and errors that appear in the students' individual study sessions.

The evaluation was carried out over one week, starting the day after the face-to-face class in the music education classroom with a group of 10 fifth graders, whose age is between 10 years and 11 years.

Before the process starts, there is a previous work by the music teacher consisting of creating the fragmentation of each of the parts that make up the song to be interpreted with the recorder in order to facilitate the process of learning it, starting from the musical

semi-phrase, then joining each phrase and finally the whole piece. This fragmentation is very important because it is an interpretive activity that depends on the coordination of the hand with the sight (an aspect that is not yet fully developed in children of this age); it must be exercised and learnt little by little. Also, it must be made up of coherent and complete musical phrases that also help develop the students' auditory memory.

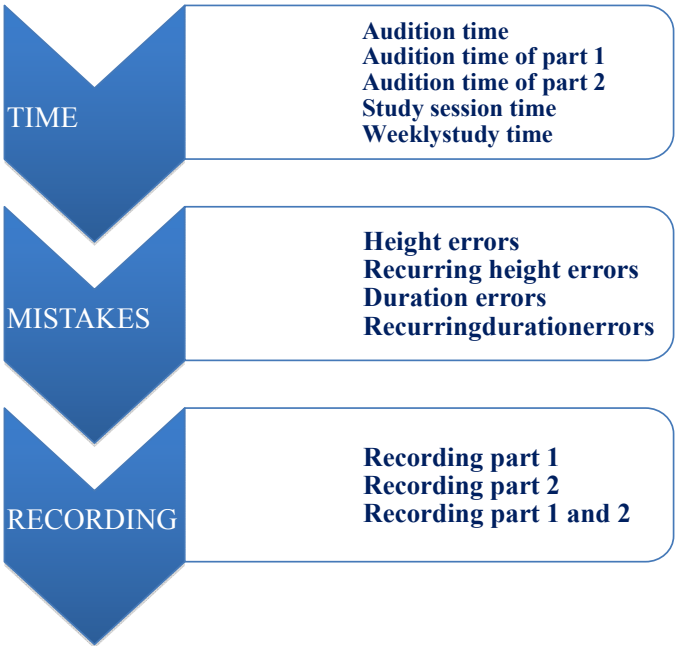
In the evaluation process of this students' group, there are 60-minute group classes in which the first part of the proposed song corresponding to the first four-measure musical phrase is studied. This phrase is made up of two semi-phrases. The importance of performing a slow and conscious interpretation is explained. Also, the teacher dedicates the necessary time of the session to clearly show the positions of the fingers corresponding to each musical note that appears in the score, remembering the importance of a correct body and manual posture and the correct way to introduce air on the instrument. In the same way, special mention is made of the rhythmic reading of the song, stopping in the measurement of each musical figure and determining its corresponding height.

After this face-to-face session, the period in which the computer tool becomes part of the study process begins since, over the next few days, it collects the data from each study session carried out by the students (until the next face-to-face class with the teacher), taking note of the following aspects:

- Time invested in the audition of all the score: we recommend complete listening to the song three times, calculating in each of them the time it lasts completely.
- Time invested in the audition of fragment 1 of the piece: it is recommended to carry out at least two complete auditions of the first fragmentation before carrying out its study, which corresponds to the first musical semi-phrase.
- Time invested in the audition of fragment 2 of the piece: it is recommended to perform at least two complete auditions of the second fragmentation before carrying out its study, which corresponds to the first musical semi-phrase.
- Total time invested in each study session: the total computation of time invested in each study session. It is better to do this on a daily basis in periods of no more than 25 minutes in a row.
- Total time invested in each study week: the total time invested in a study week, formed by the sum of the times of the daily sessions.
- Height errors made, where all the height errors made by the student are reflected throughout their weekly session. These mistakes appear if they have been made only once.
- Recurring height errors: those height errors that are repeated more than three times in the same study session; their revision is considered important in the face-to-face session.
- Duration errors: where all the duration errors made by the student throughout their weekly session are reflected. These mistakes appear if they have been made only once.

- Recurring duration errors: those duration errors that are repeated more than three times in the same study session; their revision is considered important in the face-to-face session.
- Recording of fragment 1 of the piece: the number of recordings made of fragment 1 of the musical piece and the time spent realising each one of them.
- Recording of fragment 2 of the piece: the number of recordings made of fragment 2 of the musical piece and the time spent realising each. Let us remember that the proposed study protocol recommends making at least three complete recordings of each fragment (so the duration of each must be the same as the duration of the fragment itself).
- Recording of the union of fragments: the number of recordings made of the complete musical phrase (which joins fragment 1 and fragment 2) of the musical piece and the time spent in the realisation of each of them.

Schematically, we can see all the aspects to consider when evaluating students and offering a teaching response tailored to their individual needs.



In above graph, we see three sections: time, errors and recording. The first refers to the time devoted to studying the instrument, performing the song auditions, and the daily and weekly total count. The tool sends the teacher all the errors regarding the duration and height of the sounds, especially marking the recurring ones (that is, those repeated three times within the same study session) to give an in-person answer in the class.

Finally, with regard to the recording, it is important to note that this term is used, resembling an evaluation since the students must interpret making the fewest possible errors and complying with the total duration of the song or fragment proposed from

beginning to end. This recording process takes place at the end of each study session and is very useful to mark the evolution of the students.

The computer tool sends the teacher all the information where all the data mentioned in the previous lines are collected at the students' individual level, allowing teachers to offer a thoughtful and studied instructor response that starts directly with the resolution of their difficulties, errors and doubts. With this, the optimisation of class time is evident, as well as the complete improvement of the teaching-learning process of the students.

In the following Table 1, we see the information from the 10 students with the evaluation carried out and the items taken into account throughout the process.

In Table 1, we can see each of the items the students must complete successfully. Likewise, we can see each student's level of improvement for each item (for example, S.1, the first student taken into account for the evaluation and so on until the last one).

Table 1 Results of the study at home

Items	*S.1*	*S.2*	*S.3*	*S.4*	*S.5*	*S.6*	*S.7*	*S.8*	*S.9*	*S.10*
Audition time	2	2	1	2	x	2	2	x	x	2
Audition time of part 1	1	2	1	1	x	1	2	1	x	1
Audition time of part 2	1	1	1	1	x	1	1	1	x	3
Study session time	2	2	1	2	x	2	1	1	3	2
Weekly study time	2	2	1	2	x	2	1	1	2	2
Height errors	2	2	2	2	1	2	2	3	2	2
Recurring height errors	1	2	1	2	1	2	2	2	2	2
Duration errors	2	2	1	2	1	2	2	3	3	2
Recurring duration errors	1	2	1	2	1	2	2	2	2	2
Recording part 1	2	2	1	2	x	2	1	2	2	2
Recording part 2	2	3	1	1	x	2	2	2	1	2
Recording part 1 and 2	2	3	1	2	x	2	2	2	2	2

The numbers indicate the degree of improvement between the first feedback the computer tool sends to the teacher after the first week of study and the second. It is very important to note that between one feedback and another, there is the teacher's response, made up of all the advice and teachings offered by the teacher (individually or in a group) to improve those errors that persist and advise on the importance of complying with the proposed study protocol.

Therefore, we see that the numbers appear in the table: 1, 2 and 3 and an 'X' also appears. The number one indicates an improvement between the first and second feedback, fulfilling the proposed study protocol more than 80/90% of its totality, including the reduction of errors and computation of the time proposed in the realisation of each one. For its part, two refers to the same but with 60/70% completed and number three to a total computation of 40/50% improvement with respect to the first feedback sent to the music education teacher. Finally, the X means that there has been no improvement in the information collected in the first feedback with respect to the second (although it has not worsened, of course).

With all the data, we can conclude that each student improves in each percentage in the following computation of the 12 items proposed.

As shown in Table 2, the evaluated students present considerable improvements that include between 70 and 90% of improvements between the percentages collected in the first and second feedback. In very few cases, it is reflected that this improvement is not substantial, and in the sections in which there is no improvement, it is because the student had successfully completed the items proposed.

With this, it is found that incorporating the computer application in the teaching-learning process of students notably improves the quality of study and results obtained in the interpretative advances made with the recorder.

Let us not forget that the role of teachers is still fundamental since the previous preparation is going to be presented to students as their task, and the response given in class to the problems and errors is fundamental for the demonstrated improvement between the results obtained from the first feedback compared to the second.

Table 2 Statistics of improvements

Student	*80/90%*	*60/70%*	*40/50%*	*Items that do not improve*
1	4	8		
2	1	9	2	
3	11	1		
4	3	9		
5	4			8
6	2	10		
7	4	8		
8	4	5	2	1
9	1	6	1	1
10	1	9	1	

4 Conclusions

To sum up, it is necessary to remember the impossibility of carrying out an individualised teaching-learning process that considers the students' personal interests and their different learning rhythms (something that, with the traditional method, is impossible to carry out). This is due to the difficulty of serving a large group of children in a single face-to-face class of only one hour a week. In the same way, the continuous evaluation process that considers not the result but the process carried out to achieve the proposed objective becomes practically impossible since it is not possible to collect real data from all the students during that class period.

For this reason, including the computer tool as an educational complement substantially improves, as demonstrated in this article, the teaching-learning process of students. On the one hand, it helps children improve in the performance of their study, helping them identify failures in real-time, offering solutions to counteract them and offering them the possibility to comply with a protocol previously marked by the specialist teacher. On the other hand, from the teachers' point of view, the inclusion of the computer application is also beneficial since it offers objective and daily information on each study session, evidencing the recurring failures and problems in it. In this way, teachers can prepare the class in advance and optimise the time of the only face-to-face

session they have with their students. Likewise, thanks to these collected data, a continuous (and summative) evaluation can be carried out without any problem based on real and constant monitoring in which the evolution of each student is reflected.

The future lines of research for this work are mainly the following:

- Development of the quality of student feedback beyond the individual, achieving a group response that is easy to interpret in a short time. With this, the teacher will have an overview of the entire group class before starting the face-to-face session, in addition to having individual information about each week of student study.
- Expansion of the computer tool, so it is able to do polyphonic monitoring. Let us remember that this proposal uses a tool that identifies individual sounds of the recorder, that is, monody. Therefore, a step further would be to do the same with several melodies played simultaneously.

References

Boza, A.C. and Toscano, M. (2012) 'Motivos, actitudes y estrategias de aprendizaje: aprendizaje motivado en alumnos universitarios', *Profesorado. Revista de Currículum y Formación del Profesorado*, pp.125–142. Doi: redalyc.org/pdf/567/56724377008.pdf.

Byo, J. and Cassidy, J. (2008) 'An exploratory study of time uses in the practice of music majors self-report and observation analysis', *Applications of Research in Music Education*, Vol. 27. Doi: 10.1177/8755123308322272.

Duran, D. and Vidal, V. (2004) *Tutoría entre iguales: de la teoría a la práctica. Un método de aprendizaje cooperativo para la diversidad en secundaria*, Graó, Barcelona.

Escudero, M.P. (1990) *Canciones para Flauta Dulce soprano y guitarra*, Real Musical, Madrid.

Escudero, M.P. (1992) *65 canciones para dos voces iguales o flautas dulces*, Real Musical, Madrid.

Esquivel, N. (2009) 'Orff schulwerk o escuela orff: un acercamiento a la visión holística de la educación y al lenguaje de la creatividad artística', *La Retreta*, No. 2, pp.1–6.

Forcada, C. (2008) *Tipos de práctica en la enseñanza instrumental*, Revista de divulgación musical Relafare, Vol. 12, No. 1.

Gregg, M., Clark, T. and Hall, C. (2008) 'Seeing the sound: an exploration of the use of mental imagery by classical musicians', *Musicae Scientiae*, Vol. 12, No. 2, pp.231–247.

Hallam, S. (1995) 'Professional musician's orientations to practice: implications for teaching', *British Journal of Music Education*, No. 12.

Hidalgo, J. (1994) Canciones y piezas célebres para Flauta Dulce, Editorial Música moderna S.A., Madrid.

Jambrina, M.E. (2017) *La flauta dulce en el área de expresión artística de la educación primaria*, *Comunidad autónoma de Extremadura: realidad, implicación y propuesta para el profesorado*, Universidad de Extremadura, Facultad de educación, Departamento de didáctica de la expresión musical, plástica y corporal, Badajoz.

Jorgensen, H. (2000) 'Student learning in higher instrumental education: who is responsible?', *British Journal of Music Education*, Vol. 17, pp.67–77. Doi: 10.1017/S0265051700000164.

Kageyama, N. (2013) *Bulletproof Musician. How many hours a day should you practice*. Available online at: https://bulletproofmusician.com/how-many-hours-a-day-should-you-practice/

McDowal, J. (2009) 'Making music multimodally: young children learning with music technology', *The International Journal of Learning*, Vol. 16, No. 10.

Molina, E. (2012) *Automatic Scoring of Singing Voice based on Melodic Similarity Measures*, Master Thesis in Sound and Music Computing, Universidad Pompeu Fabra.

Oare, S. (2012) 'Decisions made in the practice room: a qualitative study of middle school students' thought processes while practicing', *Update: Applications of Research in Music Education*, Vol. 30. Doi: 10.1177/8755123312437051.

Reynolds, N.J. (2005) 'The computer as scaffold, tool and data collector: children composing with computers', *Education and Information Technologies*, No. 10.

Salmon, P. (1990) *A psychological perspective on musical performance anxiety: a review of the literature.* Available on line at: https://www.sciandmed.com/mppa/journalviewer.aspx?issue=1137&article=1375&action=1

Sloboda, J. (2000) 'Individual differences in music performance', *Trends in Cognitive Sciences*, Vol. 4, No. 10. Doi: 10.1016/S1364-6613(00)01531-X.

Sloboda, J. (2010) 'Individual differences in music performance', *Trends in Cognitive Sciences*, Vol. 4, No. 10.

Topping, K.J. (2005) 'Trends in peer learning', *Educational Psychology*, Vol. 25, No. 6, pp.631–645

Videla, M.A. (1980) Repertorio de iniciación para Flauta Dulce soprano: con acompañamientos diversos (piano, guitarra, percusión).

Willems, E. (1981) *El valor humano de la educación musical*, Barcelona, Paidós.