Serious Games for Music Education
A Mobile Application to Learn Clef Placement on the Stave

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Abstract: According to recent researches, gaming can be used in educational contexts to improve learning processes. In this work, at first serious games are introduced by defining their key features, then their applicability to the music education field will be discussed. Finally, the paper will present a specific case study focusing on real-time solfège of scores with frequent clef changes. The resulting pedagogical game, called *iClef*, has been designed and implemented to run on mobile devices such as the iPhone and iPad.

1 INTRODUCTION

Recent research has shown that gaming can be profitably used in educational contexts, in order to make the learning process both effective and amusing. Serious games (Abt, 1970) are designed for purposes that go beyond mere amusement. Like any game, they are intended to entertain users, but their main goal is usually to train and educate them. In other words, the recreational aspects of serious games act as a sort of Trojan horse to convey computer-supported education. The effectiveness of games as teaching tools is due to their potential to engage players.

The term "serious game" was actually used long before the introduction of computer and electronic devices into entertainment, but our concern in this article is with the application of information technology to educational processes. The article (Zyda, 2005) provides an up-to-date definition for serious games, depicting them as "mental contests, played with a computer in accordance with specific rules" that use entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.

This paper addresses a specific field, namely music education. Serious games could be applied to this domain for a number of different purposes. For instance, it is possible to teach the key concepts of music theory and instrumental practice through *ad hoc* hardware and software frameworks based on selected music materials. The huge success of entertainment-oriented applications like the celebrated *Guitar Hero* (Arsenault, 2008), released for all the principal gaming platforms and PC systems from 2005 on, witnesses not only the pedagogical but also a huge commercial interest towards this kind of products.

In order to provide a comprehensive discussion of the matter, Section 2 presents a brief review of related works, whereas Section 3 is devoted to fixing specific goals for our serious game. Finally, Section 4 describes *iClef*, namely an example of music serious games implemented by the authors.

2 RELATED WORKS

The scientific literature about computer-based serious games somehow dealing with music is very rich. Researches and implementations range from simulated instrumental practice to advanced ear training, from alternative ways for music composition to graphical representation and analysis of scores, from gesture recognition to motion tracking techniques aiming at controlling music and/or audio parameters. Moreover, the iPhone, iPod and other popular mobile devices intrinsically support music digital libraries, thus their environment encourages applications where music can be employed in an unconventional way. Since the field is so wide, we will narrow our discussion to mobile-oriented applications related to music edutainment and ear training.

A first category includes the huge family of applications either simulating traditional music instruments or implementing brand new ones. For example, (Wang, 2009) describes the so-called *Smule Ocarina*, i.e. a wind instrument designed for the iPhone.

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In this mobile musical artifact, the interactions of the ancient flute-like instrument are both preserved and transformed via breath-control and multitouch fingerholes. Besides, the onboard global positioning and persistent data connection allow the users to listen to one another, thus creating a social experience. Mobile music making is becoming both a relevant field of research from a technological point of view and an evolved expression tool in an artistic perspective, as demonstrated in (Tanaka, 2004). Initiatives such as *Momu* - a mobile music toolkit (Bryan et al., 2010) - and MoPhO - the Stanford Mobile Phone Orchestra (Oh et al., 2010) - witness this new tendence.

In our short review, it is worth citing researches about gesture, motion capture and physical metaphors in designing mobile music performances. An example is contained in (Dahl and Wang, 2010), based on the metaphor of a sound as a ball. Exploring the interactions and sound mappings suggested by such a metaphor leads to the design of a gesture-controlled instrument that allows players to "bounce" sounds, "throw" them to other players, and compete in a game (called *SoundBounce*) to "knock out" others' sounds. The soundscape is designed so that all actions and changes of state have audible correlates, allowing both players and audience to perceive what is happening without any explicit visual information.

In the music education context, there are many interesting initiatives and applications based on mobile devices. For instance, (Zhou et al., 2010) describes the experience of *MOGCLASS*, namely a system of networked mobile devices to amplify and extend childrens capabilities to perceive, perform and produce music collaboratively in classroom context. Another relevant example is represented by *Rhythmatical* (Moorefield-Lang and Evans, 2011), designed to be an educational application for the iPhone and iPod Touch that conveys mathematical topics via musical, rhythmic, or movement interactive techniques.

With respect to the applications and approaches reviewed in this section, our work is focused on a very specific matter, often referred to as *clef reading*. In this sense, our software takes advantage from the mentioned experiences as regard the use of mobile technology and interface design.

3 HOW TO PRACTICE SIGHT READING IN DIFFERENT CLEFS

In modern notation, usually three clefs (namely three graphical symbols) are used to notate music, i.e. *G*, *F*, and *C*. Each type of clef assigns a different reference note to the line on which it is placed. Modern notation often assigns a standard position to the three cited clefs; nevertheless, in order to facilitate writing for different tessituras, any of the clefs may theoretically be placed on any of the lines of the staff. This practice was common in renaissance and baroque music, above all in vocal pieces such as motets and madrigals. However, modern instrumentation and orchestration texts, such as (Blatter, 1997), suggest their use for some instrument scoring: e.g. the alto clef is a common one for viola, as well as the tenor clef is typical of trombone scores.

Since there are five lines on the stave, and three clefs, it might seem that there would be fifteen possible clefs. Six of these, however, are redundant clefs, so only nine possible distinct clefs are allowed and have been historically adopted: the G-clef on the two bottom lines, the F-clef on the three top lines, and the C-clef on any line of the stave except the topmost, which is deprecated. Each of these clefs has a different name based on the tessitura for which it is best suited: Treble, and French violin clef (symbol: G-clef); Bass, Baritone, and Sub-bass clef (symbol: F-clef); Alto, Tenor, Baritone, Mezzo-soprano, and Soprano clef (symbol: C-clef). The keys listed above are graphically shown in Figure 1.

In Italian conservatories, sight reading of scores containing frequent clef changes is one of the tests the final exam of *Music Theory and Solfège* is made of. Figure 2 provides a hand-written example of this kind of examination. Since for most young music students practicing clef reading is an unusual and dreary activity, our purpose is providing them with a serious game oriented to this specific task. The mobile application described in the next section, called *iClef*, should do the job.

4 CASE STUDY: LEARNING CLEFS ON A PORTABLE DEVICE

iClef is a serious game which addresses the problem of correctly reading note pitches when the clef is not only a commonly used one, such as a treble or bass clef. The interface shows notes with no rythmic indication, written on a staff that carries randomly selected clefs, at an increasing metronome rate. In order to help the user, smaller noteheads suggest the next notes written in the current clef. The user has to choose the right corresponding key on a piano-like keyboard as quickly as possible. The interface

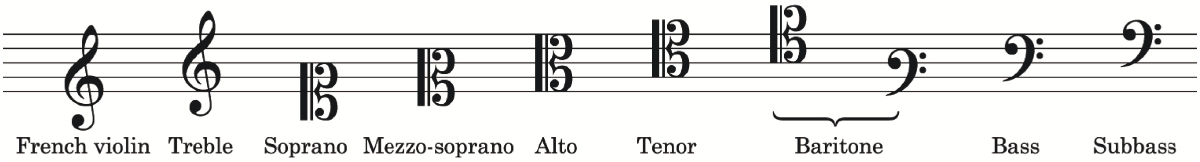

Figure 1: Clef types and their placement on the stave.

Figure 2: An example of final examination from an Italian conservatory.

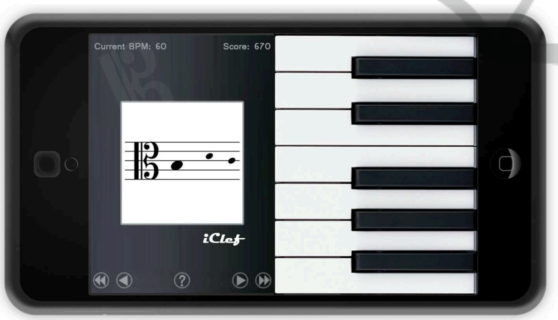

Figure 3: The interface of *iClef*.

is shown in Figure 3.

4.1 Gameplay

The key idea is providing the player with a very simple graphical interface, where the main game controls - namely the music keys - are located on the right side and are easily accessible through the thumb. In fact, the user must be able to give a prompt response to the notes graphically shown in the left panel.

The game is organized in a number of levels, each one presenting an increasing degree of difficulty. It is worth underlining that melodies are not predefined, but they are computed in real-time by taking into account both music-related rules and player performances. The former aspect is detailed in the following subsection, where some notation obstacles are listed.

After a given number of mistakes, the player is not allowed to access the next tier.

4.2 Levels and Scoring

Like any other game, in order to catch the attention of the player and to stimulate his/her abilities, *iClef* presents increasing degrees of difficulty.

A first aspect is the overall metronome, which establishes through its beats when a new note should appear. Needless to say, a slow metronome is adequate to the very first levels, whereas it becomes faster and faster as the game goes on.

Besides, the number of clef changes can dramatically impact on the degree of difficulty, so the rate increases from level to level according to $n = (11 - l)$, where n is the number of notes occurring between two clef changes and $l \in [1..10]$ is the current level.

Another aspect taken into account is melody complexity. In fact, a step-by-step melody (often known as *conjunct motion*) is intrinsically easier to read than a line with wide intervals. In this case, the number of scale grades that separate the endpoints of the (either ascending or descending) interval is $i \in \mathbb{N} : i \leq l$. As an example, at level $l = 1$ only 1-grades (ascending and descending second) intervals are allowed. There is a relevant exception to this rule: when a clef change occurs, the random interval is not related to the previous note in the sequence, but to the base line of the new clef. Only in this case, unison is allowed.[1] For instance, at level $l = 1$ and under a treble clef, the first pitch is one of F, G, or A, independently of the previous pitch under the old key.

Since accidentals and ledger lines make the reading exercise harder, they are progressively introduced in the higher levels. As regards the former aspect, for $l \in [1..4]$ the algorithm chooses only natural notes, for $l \in [5..8]$ single accidentals (i.e. sharp and flat) are introduced, and finally for $l \in [9..10]$ double accidentals may appear.

During the gameplay, the interface provides a variable number of clues which provide in advance information about the next notes (graphically indicated by small symbols). In the easier levels clues are two, but they gradually disappear in higher levels.

All these aspects are conveniently mixed during

[1] Please note that in general terms the concept of interval implies the distance between two pitches, whereas in this case the "unison" occurs between a real pitch and the virtual pitch indicated by the clef position.

the gameplay, so that the task becomes harder and harder.

The player's performances are mainly measured in terms of right-answers rate, and this is the key aspect to extend play to higher levels. However, scoring is influenced also by his/her reaction time: a prompt response results in a higher score for the current note, and a series of quick responses gives bonus points.

5 CONCLUSIONS AND FUTURE WORKS

The present paper has addressed the issue of serious games' application to a specific domain of computer-supported education, namely music training. Unlike many other approaches, here the professional vocation of the entertainment activities is stressed. In fact, the target is represented by young students who attend music conservatories rather than video gamers fond of music.

This serious game allows the improvement of score following for some instruments - e.g. violas and trombones - and for specific repertoires as early vocal music, whose typical ensemble is *Cantus*, *Altus*, *Tenor* and *Bassus* (Kurtzman, 1994). The resulting pedagogical application has been tested on several classes of music students. In all cases, such an approach has produced a high level of amusement and involvement in students, which has been evaluated through blind questionnaires. This is a relevant result for our research, since clef reading is usually considered either an annoying or a challanging activity. Needless to say, relevant differences emerged depending on the age and the degree of music students.

Future works may take advantage from a wide user acceptance test, paying special attention to aspects such as usability, learning effectiveness and player amusement. Besides, we are interested in releasing such a game for other platforms, including a Web version. Finally, other aspects of music theory (e.g. rhythmic ear training or music dictation) could be investigated.

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REFERENCES

Abt, C. (1970). *Serious games*. Viking Press.

Arsenault, D. (2008). Guitar hero: "not like playing guitar at all"? *Loading...*, 2(2).

Blatter, A. (1997). *Instrumentation and orchestration*. Schirmer Books.

Bryan, N., Herrera, J., Oh, J., and Wang, G. (2010). Momu: A mobile music toolkit. In *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME), Sydney, Australia*.

Dahl, L. and Wang, G. (2010). Sound bounce: Physical metaphors in designing mobile music performance. In *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME), Sydney, Australia*.

Kurtzman, J. (1994). Tones, modes, clefs and pitch in roman cyclic magnificats of the 16th century. *Early music*, 22(4):641–665.

Moorefield-Lang, H. and Evans, M. (2011). Rhythmatical: A game to combine music and mathematics for mobile devices. *Music Reference Services Quarterly*, 14(1-2):46–51.

Oh, J., Herrera, J., Bryan, N., Dahl, L., and Wang, G. (2010). Evolving the mobile phone orchestra. In *Proceedings of the International Conference on New Instruments for Musical Expression*.

Tanaka, A. (2004). Mobile music making. In *Proceedings of the 2004 conference on New interfaces for musical expression*, pages 154–156. National University of Singapore.

Wang, G. (2009). Designing smules iphone ocarina. In *Proceedings of the International Conference on New Interfaces for Musical Expression. Pittsburgh*.

Zhou, Y., Percival, G., Wang, X., Wang, Y., and Zhao, S. (2010). Mogclass: a collaborative system of mobile devices forclassroom music education. In *Proceedings of the international conference on Multimedia*, pages 671–674. ACM.

Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer*, 38(9):25–32.