Building the Case for Video Games in Music Education

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***Abstract*— Considering educational games as interactive metaphors for learning material, we suggest in this paper that PlayStation-like gamepads are appropriate user interfaces that enable students to play with musical concepts without being hindered by their own instrumental limitations. Our proposal builds upon current pedagogical research that shows that fun games increase learners' motivation and foster collaboration, crucial issues in music practice.**

We survey key technologies that are currently been used to support music teaching, together with their pedagogical underpinnings. We then discuss a general framework within which games can be seen as proper vectors for music material. Finally, to substantiate our claims and follow "learning by doing" constructivistic principles, we introduce a specific example of a two-player jazz game aiming at improving students' abilities to express their own musical creativity.

We intend to implement a version of this game focused on teaching sound control, improvisation and musical exploration within a Java-based game platform.

***Index Terms*— computer game, game-based learning, gamepad, improvisation, music education.**

I. INTRODUCTION

Information technologies have been used for quite a while in music performance, composition or analysis. In music education, their use can be traced back to the 1970s, with the advent of Music Logo by Bamberger at MIT (see Brandão et al. [1] for an historical review).

In general, the motivations for using information technologies for educational purposes are multifaceted:

- Providing widely-accessible and structured resources to an increasing population of learners is a strategic, economical and political challenge;
- The design of new computer-based knowledge representations and teaching activities provides ways to improve the pedagogical efficiency of knowledge transfer;
- In study after study [2], it has been noticed that usage of advanced technologies can increase students' motivation, a key factor in their success.

Recent research [3, 4] suggests that video games, which use state-of-the-art computer technologies, belong to a booming industry and have a wide appeal among teenagers and young adults, can be successfully used in various educational contexts.

We intend to show in this paper (1) that video games dedicated to music education can be seen as a logical follow-up to existing technologies used in music education and (2) that one could successfully design a video game that would provide a fun way of "learning [music] by doing", contrarily to the common belief that teaching should be segregated from playing. Indeed, in music, the wide availability of game user interfaces such as PlayStation-like gamepads and the familiarity of the target audience with such devices are major advantages for such an approach, in that it paves the way to the design of pedagogical material that uncouples instrument practice from the teaching of more abstract music concepts, such as musical creativity or improvisation planning.

The structure of the paper is as follows. After this introduction, we relate, in Section 2, existing information technologies used in education to their potentials for music teaching. Section 3 is dedicated to an in-depth analysis of how music specifics impact video game for music education designs. Building on this background, we sketch, in Section 4, a proposal for Cha-Luva Swing Festival, a two-player video game that intends to help teach jazz expression. We discuss future work, mostly related to the implementation of our jazz video game, in Section 5, before concluding in Section 6.

II. FROM HYPERMEDIA TO GAMES IN MUSIC EDUCATION

We intend to briefly describe in this section some of the most recent work related to new technologies in music education. We focus on their impact on the learning material and the expected profits to students.

A. Multimedia

The vast majority of pedagogical material dedicated to music is based on multimedia documents that provide various knowledge representations: sound, score, images and text. Teachers can create their own material using dedicated authoring tools, principally for symbolic music notation (e.g., GUIDO, MIDI, SMDL, MusicTeX, various XML standards). The interactivity is here mostly restricted to hypermedia links, although the on-going Signed Listening project [5], an authoring environment that produces listening guides of musical pieces through animated score tracking, using automated graphical highlights of specific notes or parts, goes a little further.

B. Programmed Learning

The automatic sequencing of the learning material, together with its associated evaluation procedures, leads to a more autonomous and lively learning experience. A generalization of such an approach to many music components is however hindered by the lack of explicit and measurable correctness criteria. Most of these tools thus

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only deal with objectively measurable parameters found in ear-training, rhythmic dictation or music theory (e.g. the basics of classical harmony, counterpoint and melody in Arezzo [6]).

C. Distance Learning

A natural extension to the previous approaches is distance learning, where teachers can help students deal with the more artistic and less formalized aspects of music education. This also first introduces collaborative aspects to the teaching process. We sketch below three different environments built on such principles.

Using the Berkleemusic[2] site, students can access exercises that need to be turned in a week later, while teachers and other students can help via forums and mailing lists. Even though such an asynchronous technology provides flexible access to educational material, it assumes that users are already motivated to study. Moreover, as noted by Isaacson in [7], this kind of text-based solution is general-purpose and not specifically tuned to music teaching, as few interactions are possible.

The Imutus[3] project, currently under development, strives to provide a better user interface with tools such as audio-to-MIDI conversion, score alignment or 3D visualization for hand positioning. The overall goal here is to objectively compare students' interpretations to target scores.

At last, the pioneering MusicPath[4] project intends to mask distance altogether, a recurrent Canadian political issue, by using high-speed networks to remotely connect piano teachers and learners using MIDI connected Yamaha Disklaviers and a dedicated videoconference system. The experience is nevertheless limited by latency issues and interaction asynchrony, since players must take turns. The technology is intended to be completely transparent, so it doesn't offer any new insight on how to improve the learning curve.

D. Expression Workbenches

Other tools try to alleviate the lack of interactive real-time play in the systems described previously in order to develop sound manipulation, structuring and transformation abilities by students, with no arcane music notations. We describe below three typical examples.

At an intuitive level, DJ Sez offers, as part of the Jam-o-drum[5] project developed at CMU, a collaborative environment in which players can experiment with hip-hop-type sounds. The overall goal here is mainly to foster communication between individuals and their own expression within a group. It has no musical educational goal per se.

MusiqueLab[6] is a multi-thematic laboratory in which students can explore, at an introductory level, various concepts such as notes' height and intensity, rhythms, modes and scales. The learning process can be either guided by a teacher, who would suggest a series of experiments, or self-guided, in which case the student would play with the environment as if it were her own instrument.

For advanced learners, expert-system programs such as the Continuator [8] can play the role of improvisational partners, enabling a dialog between the musician and his "digital" mirror, the system using machine learning technologies to provide imitative chorus responses. Education-wise, when using such a system, a musician can develop new musical ideas, while possibly discovering existing limitations and automatisms in his own playing technique.

To get most out of these sophisticated tools, a teacher is probably required, to give meaning to the musical phenomenons they manipulate. He may provide structuring frameworks, as suggested by Veitl [9], in order to help students find interesting exploration paths and, this way, maintain their interest by avoiding random expression.

E. Games

Games are the ultimate tool to create and maintain motivation [4] in students. Moreover, recent work [10], [11] has shown that useful skills can be developed while practicing such games: motor (coordination, dexterity and reflexes), cognitive (deduction, critical thinking, decision making, strategy) and social (collaboration, competition).

Educational video games have been designed in various fields. They are all based on a common credo: providing interactive metaphors of knowledge. For instance (see The Education Arcade[7] for a larger set of examples), in Replicate, the player acts as a virus that tries to kill its host in a 3D immersive virtual world, i.e. the human body; in Supercharged!, the game physics uses Maxwell's electromagnetic laws to constrain an electron's path in a race competition; in Revolution, one can experience the events of the American revolution within a virtual community of players. Here the student has to acquire an intuitive understanding of the knowledge to be learned in order to develop effective strategies to progress within the game and interact with other players. This way, a student's progress within the game can be considered as a proxy for her evaluation, which can make for a fun way to pass exams!

As far as music is concerned, sound interaction is usually absent from commercial video games, or lacks educational purpose otherwise. Nonetheless, rhythm video games such as Samba de Amigo are quite successful in Japan; their gameplay is based on reproducing a given sequence in sync with a soundtrack using buttons or specially designed input interfaces such as plugged Maracas. Rhythm Breaker, also part of the Jam-o-drum[5] project, offers what amounts to a competitive multi-player Tetris-like time-matching game in which players have to follow imposed temporal patterns. The main educational by-product of such systems is dexterity and memory, but players are mere reproducers and have no musical control.

Some genuine audio games with no video support, such as the audio Mastermind presented by Targett et al. in [12], in which token colors are replaced by melodies and auditory icons, have been originally designed for visually impaired persons, but may be used by any hearing one. This kind of games is found very challenging since the players need to develop aural dexterity (pitch perception, sound concentration and memory).

[2] http://www.berkleemusic.com/
[3] http://www.exodus.gr/imutus/
[4] http://musicpath.acadiau.ca/
[5] http://www.jamodrum.net/
[6] http://www.educnet.education.fr/musique/
[7] http://www.educationarcade.org/

III. TOWARDS A MUSICAL GAME

Our goal, building upon the results of these previous ideas, is to blend the concepts of music theory with the practice of their use within a "plugged" learning game environment. Students would thus acquire an intuitive understanding of various modes of play via gamepads through a collaborative creative process.

A. Music Gaming

Building upon Pratt [13], for whom playing music is about creating "un espace-temps social et corporel imaginaire" (an imaginary bodily and social space-time), musical expression rises from a playing field located between body and language. This field is ruled by esthetic (culture, style, audience and own artistic choices) and technical (instrument, location, abilities) constraints. As with Caillois's player [14], the musician's pleasure evolves between *paidia* (uninhibited fantasy) and *ludus* (goal-reaching desire).

In traditional music education, *ludus* is overemphasized over *paidia*, since mastering musical instruments or notation are very time-consuming processes that delay spontaneity and sharing between musicians. Designing music environments with no entry barriers due to instrumental dexterity or abstract knowledge would get us closer to a genuine game setting, thus increasing students' pleasure and motivation. Moreover, as noted by Flusser [15], improvisation seems to be the right ludic activity (what we call *music gaming*), in opposition to interpretation, where potentiality is quite strictly delimited by scores.

B. Introducing Rules

We can now see that the expression workbenches we surveyed above seem to help us getting closer to our goal. Still, we need to shift *paidia* from technical musical constraints to the crucial notions of mission, story progression and strategy present in genuine video games. We intend to get pedagogical benefits from this change, and thus alterate the "unproductive" aspect of games as defined by Caillois.

Our proposal is to encode pedagogical material in game rules. A successful design should then mask the "productive" side of our game, while mission fulfillment would automatically provide us with an evaluation procedure of students. We provide an example of a set of such rules in the next section.

Note that our approach doesn't preclude the input from a teacher, who could in fact even be a player in the game, and whose assessment on subtle aspects such as students' creativity, responsiveness and mind set could be added to the overall evaluation scheme.

C. On the Edge

Designing a good game is, as noted by Harter [16], a subtle and unstable equilibrium game (pun intended) at the interplay of many domains: reality and imagination, rules and freedom, strategy and chance, desire and pleasure, predictability and adventure. This is even more crucial in the kind of "productive" games we have in mind, since, as students drop out because the gap between what they know and what they are asked to do is too large, players can also leave a game if it doesn't correspond to their culture, mind set[8] or preference for a particular type of game.

We don't claim to have found a perfect recipe for the ultimate motivating music education video game. Still it is clear that one of the challenges is to keep the "fun" factor high in the student/player mind while he is operating the gamepad. We need to navigate between playability and expressiveness, emphasizing originality and collaboration. This will undoubtedly require a pragmatic, trial and error approach before finding the best fit that would entice students to play often.

IV. CHA-LUVA SWING FESTIVAL

We introduce in this section a musical education game design, named Cha-Luva Swing Festival, which intends to put in practice the various notions and ideas developed above.

A. Synopsis

Here is a possible marketing presentation of the Cha-Luva Swing Festival game:

Cha-Luva Swing Festival is sinking. Competition with the Cookball Championship[9] is fierce and the audience is shrinking. What a difference just a few short months can make! Back then, the whole island of Lipa was dancing to the rhythms of a lovely music that enchanted everyone. But the new talents are moving and Cha-Luva, the swing celebrated by legendary musicians such as Don Hovadonson and Robert "Smash" Samsh, is slowly fading away.

Go meet them and reinvent Cha-Luva, the musical style that gamepaddists enjoy most. Better: become a gamepaddist yourself! Explore Chicago, New Orleans and Rio de Janeiro to get a feel for the essence of Cha-Luva: the sound of blues and latino energy. Travel, encounters and concerts will transform you into a gamepad expert.

Cha-Luva Swing Festival links exploration platform games and musical action for a couple of players. Combine your strengths, listen and play together to become the grooving duet that festivals will crave for.

B. Game Features

Cha-Luva Swing Festival is a multi-level two-player platform-based video game that combines missions and musical action. It is targeted to anyone interested in having fun playing jazz standards. Of course, the underlying pedagogical goal is, in fact, to help would-be musicians develop their knowledge of the context of jazz and their improvisation abilities. While exploring a Mario Bros-like, but musical, world, the two team players have to win over end-level bosses, represented here by challenges based on various jazz tunes. To reach the next level, one player will have to elaborate an adequate musical comping, while the other will provide the themes and choruses; both players will use gamepads, the operations of which will be parameterized by the game level.

[8] Think "bad loser"!

[9] Cookballers are mean guys who sometimes get in your way and play a strange sport inspired by milkpolo and flour throwing, under the wild sun of Lipa. For those of you who wonder where Lipa is, please note this an imaginary island located in Guillaume Denis's brain.

C. Gameplay

As seen above, Cha-Luva Swing Festival uses an alternating sequence of two distinct phases - platform and musical contest - that are described below. We only introduce here a few possible scenarios, although additional ones covering other musical concepts will be designed in collaboration with music teachers.

1) Platform Stage:

The main gameplay focus is about jumping and running (with screen scrolling) in a set of different sound-filled worlds. To achieve missions, the players have to overcome end-level bosses, described below.

The innovation we suggest is to introduce collaborative and contextual jumping, which would promote strategy and improve the players' future ability to "listen" to others. For instance, reaching a higher height is possible when rebounding on adequate sounding objects according to the current soundtrack, or if your partner plays a particular melody, possibly related to knowledge acquired in a previous musical action phase. All platform design decisions are related to creating a musical mood in an original physical environment.

2) Musical Action

This part corresponds to the end-level bosses and is the crux of our approach. To our knowledge, this is the first proposal for a live music group performance in an education video game. As an example, we describe below what a typical action scenario would look like, using here the case of the II-V-I chord sequence commonly found in jazz pieces.

Let us first focus on the comping gameplay, based on a piano jazz imitation of *Blue Bossa* by Kenny Dorham, which mainly uses the minor harmonic scale. Figure 1 presents the music and its related game material: (a) is the chord chart (not seen by the players) and (b) the target harmonic representation used in the game.

Navigating in the harmonic space depicted in (c), the comping player has to select the proper degrees, find the intended ones when a '?' is displayed or play whatever suits him when the slot is blank. He has to switch between tonalities around the bridge (third line of (b)), using the gamepad hat control (see (d)). Finally he plays a given voicing of the specified degrees within a bossa nova comping rhythm, using L to play the left hand voicing, and R for the right one. Mandating the use of both hands is a way to introduce some very preliminary intuition about swing in the curriculum. Reproducing the tune while complying with the given constraints provides points, a given amount of which is required to complete the boss in a limited time. Once the tune is learned, it might latter have to be used in the platform stage as jump spells.

But the player also has access to unconstrained expression abilities, such as the choice of hand voicing and degree substitution, triggered by specific gamepad combos. He can also enhance the rhythm in a compatible manner. Specifying such improvements is, of course, where pedagogical input provided by teachers matters the most.

Let us now switch to the themes and chorus player. We won't go into a lot of details here, since the idea is similar to the comping player. During themes, the student has to provide a saxophone imitation, grabbing notes in a shower falling from the sky, in essence defining a score. During the chorus, he is much less constrained; only a few target notes have to be grabbed and he is widely free to play whatever he wants in-between. He can change note scales, alterate them, change the timbre (through gamepad sticks), capture some motives and transform them (transpose, reverse, rhythm change, and so on). As explained above, finding here the right balance between freedom and constraints needs to be finely tuned.

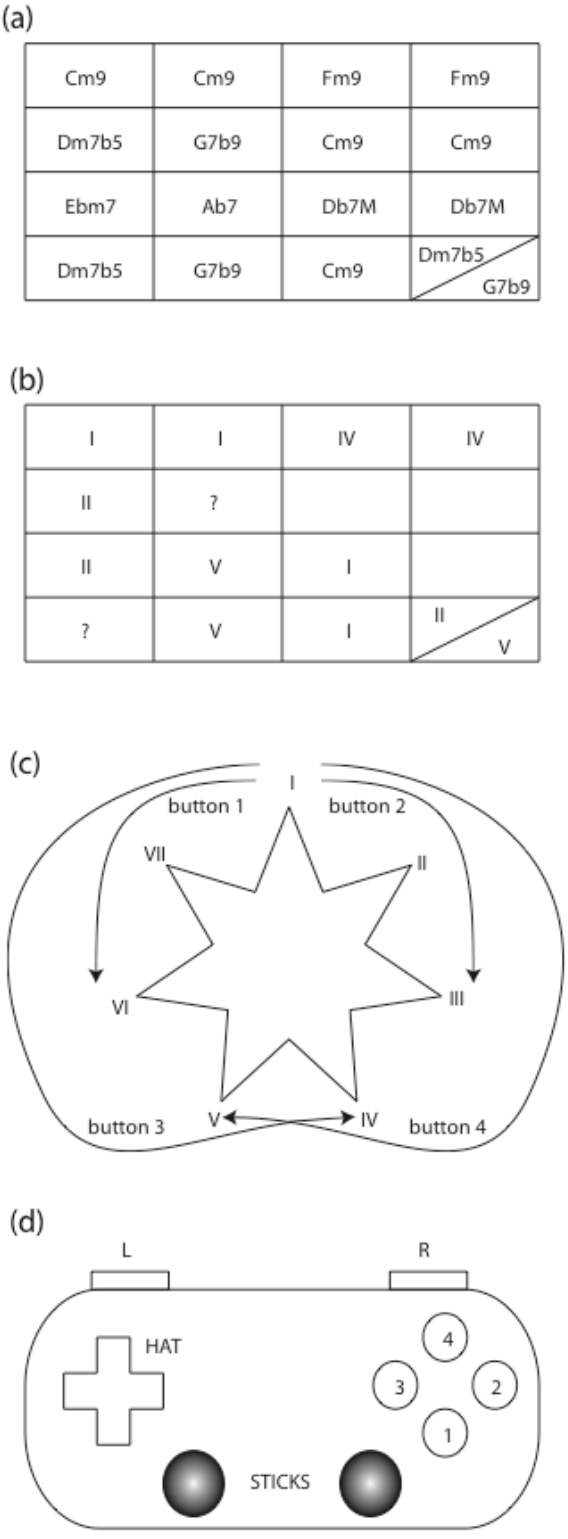

Fig. 1. Gaming *Blue Bossa*

The boss we just described is neither the easiest, since it assumes, for instance, that the player already has some knowledge of what chord substitutions and scales are, nor among the most difficult ones, which might require multiple rhythmic patterns, chord alterations, advanced expressions, or the use of complex gamepad combos to enhance the creative abilities (adding new substitutions, extensions and voicing for example, playing on chord density, on timbre). It might nonetheless be considered an adequate game action for an introduction to the II-V-I pattern.

In order to foster collaboration between players, interaction gamepad combos can, in addition, be introduced to signal the end of the chorus and restart the theme pattern, ask for a break, suggest a tempo change or enable the comping player to change the solo player's improvisation scale using modulations. The more communication there is between the students, e.g., using gamepad feedback via vibrations exchanged between players, the more points can be awarded to the team, providing various bonuses to be used in the subsequent game phases.

V. FUTURE WORK

We defined and motivated in this paper a general foundation for designing musical education video games. We intend to implement a game prototype to experimentally validate our ideas, which will extend the Cha-Luva Swing Festival game outlined above.

The current status of the Cha-Luva Swing Festival project is as follows. The general game concept and synopsis have been finalized. We have to develop new end-level bosses that will span the space of main jazz concepts. On the technology side, we implemented a multi-OS (Mac, PC, Linux) interface between a PlayStation-like gamepad and the Java environment using the cross-platform Simple DirectMedia Layer[10] library. Sound restitution is MIDI-based and performed on an external synthesizer via Sun's Java Sound API.

Ultimately, we will need to experimentally validate the merits of our approach, using a panel of users and teachers.

VI. CONCLUSION

Our paper suggests that synergies can be obtained by grouping together ideas from music, education and video games. We motivated the need for and described a collaborative musical education video game named Cha-Luva Swing Festival that intends to decouple instrument practice from music learning. Our proposal for a new paradigm in music education is particularly well suited to the video game generation, the members of which will find here a music learning tool that requires less motivation than traditional teaching methods while providing a more efficient, fun and rewarding learning experience.

The musical metaphor is focused on playing with gamepads, seen both as a toy and a friendly instrument. Eliminating instrument practice from the learning equation allows a more immediate access to creation and fun while manipulating sound and music. The set of gamepad playing modes appears then as a "muscular" encoding of the musical interaction concepts learned by the students.

[10] http://www.libsdl.org/

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