Songs2See: Towards a New Generation of Music Performance Games

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Abstract. In this paper, the concept of *Music Performance Games* is introduced and contrasted with related terms like music video games, interactive applications, and serious games. The game Songs2See is introduced as an example of *Music Performance Games* and its design stage is evaluated within a conceptual framework for serious game development. Future directions for improvement and testing of the game are outlined.

Keywords: Music game, education, score, rhythm, pitch, feedback, performance

1 Introduction & Related Work

Music video games can be defined as games where the gameplay is mostly oriented to the user's interaction with music, scores, songs or music performance. In general, the term music video game encompasses a wide variety of game categories such as dancing games, interactive composition games, rhythm games, pitch games, music management games, etc. The earliest music games developed were rhythm games where the user is required to follow a sequence or pattern of instructions such as pressing different buttons on a game controller. Popular examples of rhythm games are Guitar Hero[1] and Rock Band[2]. Later on and due to the development of solid pitch detection algorithms, pitch games became popular. In these games, the user's ability to match the pitch of a piece of music is tested. There is a clear rhythmic element in pitch games—as users are requested to produce a certain pitch at a specific time; however, the main focus of the game is on the correct intonation of a series of notes. A popular example of a pitch game is the karaoke game Singstar[3].

[1] Guitar Hero: http://www.guitarhero.com
[2] Rock Band: http://www.rockband.com
[3] Singstar: http://www.singstar.com

From an educational point of view, music video games play an important role in creating interest in music performance and musical instruments. However, transferring the skills developed in the game to the performance of real musical instruments, is not a straight-forward process [7]. For obvious reasons, game controllers cannot capture the real characteristics and intricacies of a musical instrument and are in general extremely simplified versions of them.

In the rapidly changing and technological environment where new generations grow and learn, educational methods needed to evolve correspondingly to fit their needs and life styles [3]. For this reason, interactive applications for music learning have also been developed. Here, the idea is to take advantage of the various possibilities provided by digital audio, video, and software developments to design learning applications that can support educational processes. Some commercial applications for music learning are Music Delta[4] and Smart Music[5]. Currently, the project Kopra-M[6] deals with measurement of competencies in music. For this matter, a systematic methodology and a proprietary software solution to assign and control music tasks is developed. The outcomes of this project are targeted to German secondary school students.

In the past years a few research projects have dealt with the development of E-learning systems for music education. The IMUTUS[7] (Interactive Music Tuition System), the VEMUS[8] (Virtual European Music School), and the i-Maestro[9] (Interactive Multimedia Environment for Technology Enhanced Music Education and Creative Collaborative Composition and Performance), were all European based projects partially funded by the European Commission that addressed music education from an interactive point of view. See [4] for a thorough description of these projects.

As a meeting point between video games and interactive learning applications, *Serious Games* have been developed. *Serious games* have been defined as entertaining games with non-entertainment goals. They educate, train, inform, and aim at the achievement of a predefined objective through a gaming experience [3]. Games offer an ideal medium for introducing new skills and knowledge [5] and provoke active learner involvement through exploration, experimentation, competition and co-operation [3]. They support learning because of increased visualization and challenged creativity. *Serious games* have been developed for different scenarios such as: military, humanitarian, social, business, commercial, etc. FloodSim[10], ShipSim[11], NanoMisson[12], and Food Force[13] are all examples

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[4] Music Delta: `http://www.griegmusic.dreamhosters.com/?page_id=98`

[5] Smart Music: `http://www.smartmusic.com`

[6] Kopra-M: `http://www.idmt.fraunhofer.de/de/projekte/laufende_projekte/komus.html`

[7] IMUTUS: `http://www.exodus.gr/imutus/index.htm`

[8] VEMUS: `http://www.tehne.ro/projects/vemus_virtual_music_school.html`

[9] i-maestro: `http://www.i-maestro.org/`

[10] FloodSim: `http://www.floodsim.com/`

[11] ShipSim: `http://www.shipsim.com/`

[12] NanoMission: `http://nanomission.org/`

[13] Food Force: `http://www.wfp.org/how-to-help/individuals/food-force`

of serious games. In the music field, games like Rocksmith[14], and Wild Chords[15] present structured learning goals to be achieved through the game.

In the context of this paper, the term *music performance games* will be used to refer to music games dealing with performance aspects of music such as musical instruments, rhythm and pitch. Three important aspects are considered within the definition of *music performance games*: (1) As for all games, entertainment and immersion should be critical elements. (2) The game must directly involve the production of musical sound. In other words, the actions performed by the user during the game sequence should directly result in the production of musical sounds— singing, playing a musical instrument, synthesizing sound, etc. (3) The game should attempt to achieve a specific goal within the performance aspects of music. Common examples are: playing a selected tune on the trumpet, playing major scales fluidly, singing different intervals in tune or learning to play specific chords on the guitar.

The remainder of this paper is organized as follows: Section 2 describes the game Songs2See and its main features, Section 3 introduces a conceptual framework for serious game development, Section 4 outlines some final remarks. Finally, conclusions are presented in Sections 5.

2 Songs2See

2.1 General Overview

Songs2See[16] is a *music performance game* where users can practice a selected musical piece on their own musical instrument. The basic concept behind the game is that users play to the computer microphone and the system evaluates their performance in real-time. The Songs2See Game is complemented by the Sons2See Editor. This is a software application that allows user to create their own musical exercise content from mp3 or wav files. Both in the Songs2See Game and in the Songs2See Editor, state-of-the-art music information Retrieval (MIR) techniques for pitch detection, sound separation, music transcription, and beat extraction have been applied [1, 2, 4, 6]. Figure 1 shows the game interface. It is composed of two main elements: (1) The Game View, (2) The Instrument View.

The Game View: In this part of the interface, the sequence of notes of the chosen melody is displayed. The idea behind the design of the Game View was to include as many musical elements as possible without requiring the user to have previous musical knowledge or music reading skills. The upper-half of Figure 1 shows the Game View. Some details to note:

1. A complete musical staff is displayed. The following elements were considered:

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[14] Rocksmith: `http://www.rocksmith.com`
[15] WildChords: `http://www.wildchords.com/`
[16] Songs2See: `http://www.idmt.fraunhofer.de/en/Service_Offerings/technologies/q_t/songs2see.html`
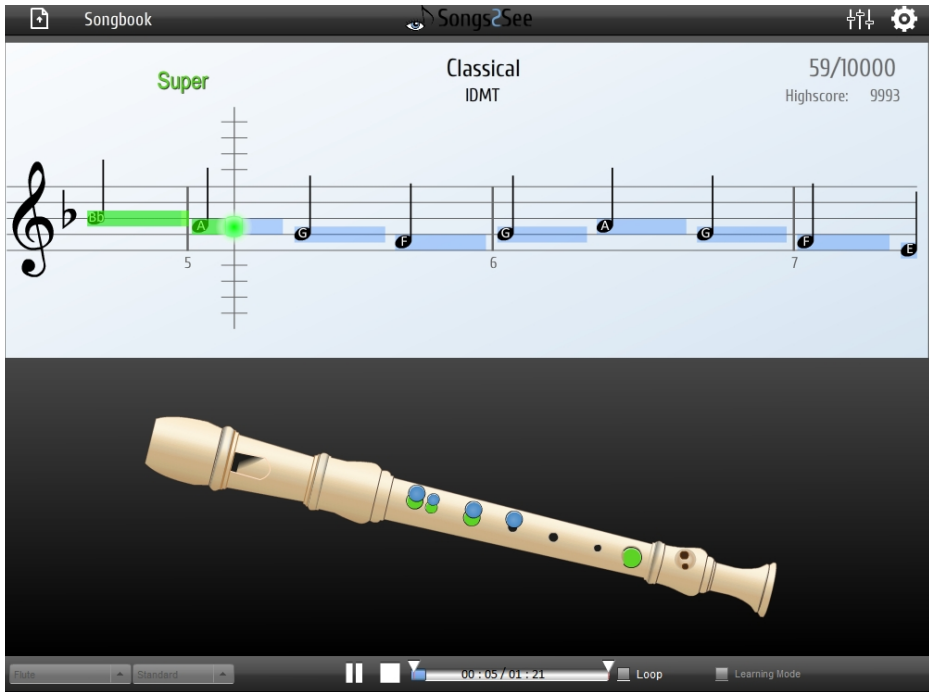
Fig. 1: The game interface. (1) Game View (upper-half) (2) Instrument View (lower-half)

- Pitch: displayed both by placing the elements in their corresponding locations in the staff and by displaying note names inside the note heads.
- Rhythm: displayed using normal music notation and length bars in the scrolling score. The time signature (see Figure 2) and bars are also displayed to give time references to the user.
- Key: the flat and sharp signs are displayed as in normal scores and key reminders are shown in the note names. In Figure 1, the key of the song is D minor equivalent to one flat (Bb). The name of the first note shown in the sequence is then Bb.

2. Real-time feedback is given in different ways: (1) The note played by the user is displayed at all times by the *Pitch Marker*. (2) When the correct note is played, the length bars are colored in green. (3) Three different colored signs are displayed to guide the user—Super, OK and Missed in green, yellow and red respectively. In Figure 1 a green "Super" sign is displayed. (4) The score obtained by the user and the highest personal score are displayed.

The Instrument View: The game supports the use of piano, bass, guitar, saxophone, trumpet, flute and voice. In the *Instrument View*, the game presents an
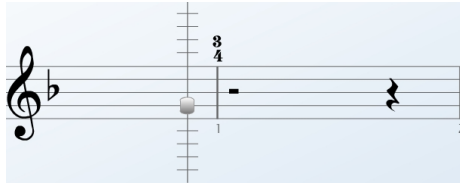
Fig. 2: Time signature displayed in the Game View.

automatic fingering animation that guides the user through the melody sequence of the chosen musical piece. For all the instruments supported, the fingering of the current note is displayed in green and the fingering of the next note in the sequence is displayed in blue. This intends to guide the user in the transition between fingering positions.
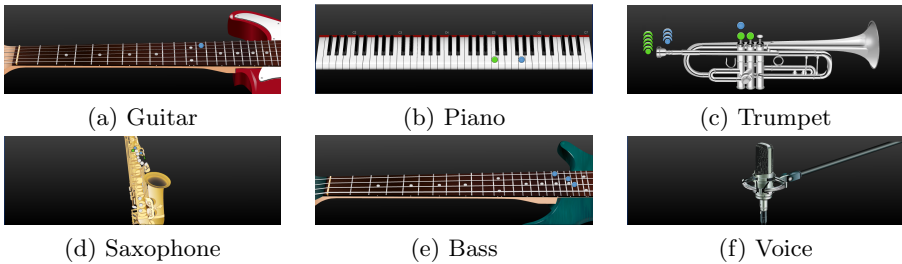

(a) Guitar   (b) Piano   (c) Trumpet

(d) Saxophone   (e) Bass   (f) Voice

Fig. 3: Instruments supported. The flute is displayed in Figure 1

3   A Conceptual Framework for Serious Game Design

In [8], a conceptual framework for serious game development has been presented. The main goal of this framework is to provide game designers and educators with a conceptual model to guide the development of serious games to be effective in the achievement of the learning goals. This model is composed of nine different elements shown in Figure 4, which will be briefly explained. Furthermore, the Songs2See game will be revised in the context of this framework.

1. Capability: Refers to the cognitive, psychomotor and affective skills that the user is to develop in the game.
   In Songs2See, the intended musical capabilities to develop are: fluid performance, effective identification, consistent element relation, timely execution, and thorough understanding.
2. Instructional Content: Refers to the facts, procedures, concepts, and principles that users should learn.
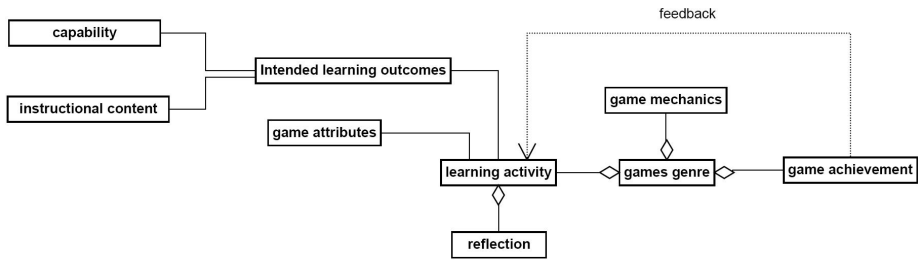
Fig. 4: Block diagram of the conceptual framework proposed by Yussof et al.

It is intended that the user understands and learns concepts as melody, notes, rhythm, fingerings, and instrumental basics with the use of Songs2See.

3. Intended learning outcomes: Can be seen as a combination of capability and instructional content. They refer to the goals to be achieved from playing the game.

In Songs2See the intended learning outcomes are: fluid performance of a melody or musical piece, effective identification of notes and of their corresponding pitches, timely execution of a sequence of notes with their corresponding durations, rapid identification of fingerings, consistent relation of notes with their corresponding fingerings, understanding of instrument mechanics and sound production principles.

4. Game attributes: These are the elements of the game that support learning and engagement.

In Songs2See several elements have been included with the goal of making the learning process more entertaining and suitable for all users [4]. *Incremental learning* for example, is supported by the included Learning Mode. Users can practice new pieces step by step until they are confident enough to play them at normal speed. *Instructional scaffolding*[17] is supported by different elements: the automatic fingering animation helps users relate pitches to fingering positions in the instrument, the option of including note names in the score helps students in the process of learning standard music notation. Additionally, rhythm learning is supported by the length bars presented in the scrolling score. *Interaction* is supported as the user is constantly presented with melodies that require timely responses and actions to be performed correctly. Furthermore, *Learner control*[18] is supported by the possibility of loading music pieces that fit the user's taste and skills. *Feedback* is given to the user in real-time so there is continuous awareness of the outcome of the performance. At the end of each performance, *rewards* are given in the form of scores based on a rating system. With the use of real musical instruments and with the inclusion of elements to bring the game close to a

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[17] Refers to the support given to the user to promote learning of new concepts
[18] Possibility given to the user to direct their learning experience to fit their own pace and progress

real performance scenario (e.g. real-time performance conditions, accompaniment tracks, music notation elements), an attempt is made to make the process of transferring skills and experiences of the game to the real world, as smooth as possible. This concept is known as *authentic learning.*

5. Learning activity: Refers to the activities designed to provide engagement an immersion in the game.
   In Songs2See two different types of learning activities are included: (1) Performance of music pieces selected by the user in the instrument of their choice. (2) Practice sets with specially designed content to address topics as scales, chord or intervals.

6. Reflection: Is the process where the user is given the opportunity to think about the learning goal and reflect about the strategy to be taken in the next activity.
   In Songs2See, this is presented in real-time. When the user plays the wrong note, the game displays the note played. The intention is that users can contrast their performances with the correct melody and possibly understand the cause of error.

7. Games genre: Refers to type or category of the game to be played. As defined in Section 1, Songs2See can be classified as a *music performance game.*

8. Game mechanics: Conditions and rules that define the details of the game.
   In Songs2See the game mechanics are simple. The user is to perform the selected piece of music with the chosen instrument in the attempt to timely and fluidly follow the sequence of notes presented by the game.

9. Game achievement: Refers to the user's level of achievement in the game.
   In Songs2See a final score is given to the user after each performance. Furthermore, a record of high scores is kept in the game to give the user some insight of previous achievements. An additional option that relates to game achievement is the tolerance value in the settings of the game. The user can select how strict the rating system should be when evaluating the performance and consequently be challenged to more accurate performances.

4 Final Remarks

The importance of analyzing Songs2See within this conceptual framework lies on the fact that clear pointers on how to improve the game and its learning potential can be obtained. In terms of *reflection* for example, offering the user the possibility of reviewing performances off-line, can potentially improve the understanding of the source of error. However, the challenge lies on doing it without withdrawing the user from the gaming environment. A plausible solution could be the design of mini-games as part of the *Learning Activities.* Here, only segments with clear difficulties— most likely selected by the users themselves— can be addressed. The mistakes made in the initial performance can be highlighted so the user can be aware of the problematic passages. Another possibility to increase *reflection* in the game, could be incorporating a recording option. Users could playback an animated version of the performance, where

mistakes are highlighted for reference. This animation could be paused and re-played as many times as the user finds it necessary. In terms of possible *learning activities*, specially designed content could be created to familiarize users with instrument mechanics. Animated description of the instruments, instructions on how to hold them, and basic explanations on sound production are all possibili-ties within the game. A reward strategy could also be devised to support *game achievements*. This could increase users' interest in outperforming themselves. A possibility could be offering sets of content or exercises, where different levels can only be reached after achieving a certain score in previous levels.

5   Conclusions

The concept of *Music Performance Games* has been presented and as an exam-ple, the game Songs2See has been described. As a guide through the development stage of Songs2See, the game has been evaluated within the conceptual frame-work for serious game development presented in Section 3. Several pointers on how to improve the design of the game and its learning potential were presented. The main goal of placing Songs2See within this framework was to optimize the designing stage so the final outcome and potential of the game are also maxi-mized. However, the learning capabilities, engagement and effectiveness of the game can only be measured when it is delivered to the final user.

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