Evaluation of an educational game for learning musical harmony

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ABSTRACT

Motivation is a fundamental element in promoting autonomy in the student, and the video game, as an educational tool, can contribute to it. The multiple benefits that educational video games can have in teaching have been studied, but can these benefits also be realized in the specific discipline of musical harmony? And more specifically, can a video game help improve the learning of musical harmony in music students? Over the last few years, various tools have been developed for music education. However, many are oriented towards exploration, with very basic theoretical content, and many others need a playful sense or elements that promote immersion. This work evaluates the flow, playability, and educational aspects of a video game for learning musical harmony, which is in its development stage.

Author Keywords

Video game evaluation; musical harmony; serious game.

ACM Classification Keywords

HCI

INTRODUCTION

During the 21st century, the use of technologies in music education has been promoted more actively [15]. Regarding technologies in music and education, Savage mentions that "if educators fail to understand this important cultural change, music as a curricular subject will move further and further away from the lives of young people, and they will find their musical education in other places" [16, p.72]. It has happened that many educators have embarked on the use of technologies not for a pedagogical purpose but with an objective of occupational preservation, which leads them to use technologies in the classroom without a clear educational purpose [15]. This derives from the fact that, even though we live in times where technologies are very close to students, this does not necessarily mean that students positively perceive using them in classes [14]. Therefore it is necessary to research and evaluate the tools to generate new ways of approaching specific learning.

Social constructivism is one of the models that best address current learning theories. This model is based on the idea that the nature of knowledge is social, and its creation is carried out individually as a construction of the experiences of each one [3]. Thus, it is declared that for significant learning, the individual must be actively involved in social activities, with interaction and collaboration with peers [2]. On the other hand, it is said that humans learn through experiences, which they store in their brains, creating simulations that prepare them to solve problems in new situations [7]. These simulations allow you to visualize different scenarios and various results, something that is very similar to what one would do in a video game.

Intrinsic motivation makes an activity fun or rewarding for its own sake and not because of an external reward, that is, "the reason that explains or justifies our actions and what leads us to perform them" [9, p.335]. Motivation in a student is always essential to promote and generate the intrinsic will to learn. This seems to be the key to constructivist teaching, where the student develops or seeks his knowledge, and video games are considered motivating agents par excellence. Also, considering that fun can be understood as something that occurs when there is high motivation in learning [9], Gee [7] suggests that all the subjects to be studied could be taken as games, where the rules have to be learned and from that way to discover how to play and apply those rules to achieve specific objectives.

Within the field of music education, there is a search for the incorporation of technological elements that help to understand theoretical topics in the musical area, where the teachers themselves have realized the need to create new approaches (such as the constructivist approach) in the classroom for the incorporation of these technologies [16]. A variety of tools have been developed for music education that can be broadly organized into three categories:

Playgrounds or Music Toys: Applications aimed at music education, such as those proposed by the MusEDLab (Music Education Laboratory, housed at New York University), Math, Science & Music (Herbie Hancock Institute of Jazz), or MusicLab (Google Chrome). However, the approaches are somewhat exploratory, with very basic musical-theoretical content.

Drill and skill: Exercise apps for reading, listening, and music transcription. While the immediate feedback is gratifying, it leaves much to be desired as a game. The motivation it generates is mainly extrinsic since these applications generally lack challenges, collaboration or competition between peers, and elements of fantasy that allow greater immersion [8].

Rhythm games: It is played with an instrument or a command, and you must play or press the keys according to a rhythm and pulse. Most games do not directly teach instrumental or vocal techniques. Instrument simulation games such as the Rock Band and Guitar Hero series are roundly criticized for simplifying and distorting the reality of instruments. Their players are derided for not being "real musicians" [12].

The video game evaluated in this project does not fit into these categories and seeks to address the learning of musical harmony from a playful and practical point of view. An investigation was carried out to create a design based on social constructivist theory, video game design principles [5], and usability principles to eliminate barriers that prevent game use [13].

THE GAME
Since music is a language, and every language has rules, the idea of creating a SCRABBLE-type crossword game using the American clef to build the chords came up. The game's objective is to achieve the highest score by making chords of three or more notes. This is achieved by placing one or more tiles on the board and creating crossword puzzles with the tiles already on the board. It is essential to fulfilling the criteria of a successful design of an educational video game that the game is multiplayer [10]. Interaction with other players is crucial within the conception of social constructivism proposed in this work; it is for this reason that playing with other people and not only with artificial intelligence is essential.

The importance of doing it online is the possibility of playing from anywhere and at any time, being able to play several games simultaneously without the need to do it synchronously. In addition, you can listen to the chord and the different notes that form it. In musical training, permanent practice is critical, which is why the possibility of playing constantly could help improve harmonic thinking skills.

METHODOLOGY
Video game usability studies focus on how the user interacts with the game, generating a flow that allows immersion [18]. The most studied attributes are those that have to do with the interface: learning, efficiency, memorability, error, and satisfaction. On the other hand, criteria have been studied to evaluate fun in games. One of them is the one proposed by Sweetser et al. [17], who created a questionnaire based on Csikszentmihalyi's idea of *flow* [4]. Flow, as Csikszentmihalyi described, is that "zone" in which one is entirely focused on a specific activity. He investigated what makes someone embark on something difficult without a tangible reward. Sweetser used eight criteria to assess what makes one game superior to another; they called this set of attributes GameFlow. The attributes are Focus, Challenges, Player Skills, Control, Clear Goals, Feedback, Immersion, and Social Interaction [17].

In addition to this, in educational games, the learning experience can be evaluated, that is, the learning objective,

the adequacy of the content, integration, feedback, extensibility, and media correspondence [1]; however, the pedagogical aspect in the Usability evaluations have been much less studied. In a review by Al Fatta et al. [1] about m-GBL (mobile game-based learning), 26 articles in specialized journals are reported, where only 6 have some usability study about pedagogical aspects, 23 have studies interface usability, and 13 on gameplay.

The evaluation focused on testing criteria related to the flow of the game and the educational aspects. Interface aspects, which had already been evaluated in previous work [11], were not assessed. For the evaluation of this game, a questionnaire was applied based on a series of attributes proposed by Fu et al. [6]. These attributes are based on those presented by Sweetser. However, they contain not only gameplay but also educational aspects, which is why they called it EGameFlow. Fu et al. proposed eliminating the attribute "player skills" and including "Improvement of knowledge" in addition to specifying statements within the different attributes with elements from the educational field. The EGameFlow questionnaire consists of 8 attributes: Focus, Clarity of Goal, Feedback, Challenges, Autonomy, Immersion, Social Interaction, and Knowledge Enhancement. Each attribute has statements that must be rated from 1 to 7. An adaptation was made in the language of the questionnaire as it is a Spanish-speaking country.

The game was tested as a prototype on cardboard, so some of the statements had to be removed to adapt it to a face-to-face game situation. The following statements were removed:

Attribute	Statement
Challenges	The game provides "hints" in text that help me overcome the challenges.
	The game provides "online support" that helps me overcome the challenges
	The game provides video or audio auxiliaries that help me overcome the challenges
Social Interaction	The game supports communities within the game.
	The game supports communities outside of the game
Goal Clarity	Intermediate goals were presented at the beginning of each scene
Feedback	I receive feedback on my progress in the game
	I receive immediate feedback on my actions
	I am notified of new tasks immediately
	I am notified of new events immediately

Table 1. Removed statements

The study was carried out on May 23 and 24, 2022, with 33 first-year students of the Composition and Interpretation career at UNIACC University in Santiago, Chile. The academic year begins in March, so the students had had around three months of classes before the experiment. The ages of participants were between 18 and 20 years old. The complete duration of the activity was 90 minutes.

- Beginning of the evaluation: The rules and the game dynamics were explained in a general way with the help of a projector. The rules were in writing in case someone wanted to consult them. Then, groups of 4 or 5 people were made, and the game was played in the key of C Major, giving them chips to play in that key. Those who finished their game could advance to another key or stay in C Major. To play in G Major, all the F tiles were replaced by F#, while when playing in F Major, all the B's were replaced by Bb.

- Dynamics of the activity: Among the players, they designate someone who will keep the scores in a notebook. The game starts, and as they find situations in the game's development, they consult the rules or the teacher in charge. After playing for an average of 60 minutes, they were told about the level system that the video game would have.

- EGameFlow test: The EGameFlow test was applied through Google Forms.

RESULTS

Attribute	Statement	Average
Concentration	Most of the gaming activities are related to the learning task	6.8
	No distraction from the task is highlighted	6.5
	Generally speaking, I can remain concentrated on the game	6.5
	I am not distracted from tasks that the player should concentrate on	6.2
	I am not burdened with tasks that seem unrelated	6.5
	The workload in the game is adequate	6.7
Goal Clarity	Overall game goals were presented at the beginning of the game	6.8
	Overall game goals were presented clearly	6.5
	Intermediate goals were presented clearly	6.5
Challenge	The difficulty of challenges increase as my skills improved.	6.6
	The game provides new challenges with an appropriate pacing	6.6
	The game provides different levels of challenges that tailor to different players	6.6

Attribute	Statement	Average
Autonomy	I feel a sense of control and impact over the game	6.5
	I know the next step in the game	6.5
	I feel a sense of control over the game	6.3
Immersion	I forget about time passing while playing the game	6.5
	I become unaware of my surroundings while playing the game	6.2
	I temporarily forget worries about everyday life while playing the game	6.2
	I experience an altered sense of time	6.2
	I can become involved in the game	6.7
	I feel emotionally involved in the game	5.9
	I feel viscerally involved in the game	6.2
Social Interaction	I feel cooperative with other classmates	6.5
	I strongly collaborate with other classmates	6.5
	The cooperation in the game is helpful to the learning	6.7
	The game supports social interaction between players	6.8
Knowledge Improvement	The game increases my knowledge	6.9
	I catch the basic ideas of the knowledge taught	6.9
	I try to apply the knowledge in the game	7
	The game motivates the player to integrate the knowledge taught	7
	I want to know more about the knowledge taught	6.8

Table 2. Results on attributes and statements

Some comments from the players
"I think it's a great game that relates theoretical content with playful practice, which makes it possible to take the concept out of classes and apply it on a daily basis with my peers."
"The game is clearly understood, and the rules are understood logically, it is not necessary to resort to instructions after the mechanism is understood"
"Not only does it entertain the player, but it also promotes learning in an impressive way, having different levels, which allows not to stagnate and continue learning."

Some comments from the players
"Entertaining game, could be a good interactive learning method for students, innovative and easy to play."
"I thought the game was quite good, I think there should be more chips to make it a slightly longer game since one is focused on it and is left wanting more at the end of the round."
"All the participants brought out our competitive sides, but at the same time helping each other to be able to move forward with the game and to be able to reach new stages in the game."
"The game is super fun, I had a great time playing with my teammates, and I feel that it has helped me form chords faster just by thinking"
"Very good game, it surprised me, it totally increases my knowledge and makes me want to know more to apply it in the game. I wish there could be an application for phone or PC"

Table 3. Student comments

ANALYSIS AND INTERPRETATION OF RESULTS

Players stay focused during the game and focus on the tasks they should concentrate on. It can also be seen as a game that entertains and educates, containing necessary elements of interaction between players that enhance knowledge and fun.

The game has clear objectives that allow its smooth development, and the feedback is adequate, giving information about the success or failure of the players' moves. In the face-to-face game, the game partners provided input when approving or rejecting a play, with the explanation and point count. This attribute is strongly linked to social interaction, a fundamental aspect of fun and learning.

The result also indicates that the game offers different challenges that are presented at an appropriate pace and that the player feels a sense of control and impact on the game. Their actions influence the game's outcome, and they know the next step.

In the beginning, some players needed help understanding the logic of the game immediately; however, once they understood, there was no problem continuing in the dynamics and advancing in the game. The game is easy to learn but requires knowledge to master and progress to more complicated stages, making it a challenging game regardless of the player's level of expertise. The results show that knowledge is used during the game, and it is necessary to keep learning to improve performance. The game promotes the search for knowledge outside the game.

CONCLUSION

It is essential to highlight the excellent reception of the game among the students. High involvement in the game could be observed, staying beyond the established time to finish the games. This may be due to the limited supply of high-level games in music theory and the enthusiasm for using their new knowledge in a game context outside the classroom. Playing and applying knowledge, rather than generating frustration for not winning the game, generates an impulse to learn more. The data collected in this work, added to those obtained in previous tests [11], validate the tool from the point of view of the interface and gameplay in the design and development stage.

As it is a cardboard prototype, it is not yet possible to appreciate all the video game's possibilities, such as stages, scores, ranking, and the possibility of playing asynchronously. Once implemented online, it will be interesting to make an experimental design that accounts for the possible educational benefits in more detail and over time. On the other hand, seeing that it works well as a cardboard game, a comparative experiment could be conducted to know each modality's differences, benefits, and limitations.

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