

# Designing a Serious Game to Enhancement of Musical Skills of Children Using iPlus Methodology

Verónica Maldonado-Garcés<sup>1</sup>, Elking Araujo<sup>2</sup>, Mayra Carrión-Toro<sup>3</sup>, Marco Santórum<sup>3</sup>, Patricia Acosta-Vargas<sup>4</sup>, Diana López<sup>3</sup>, Mahatma Quijano<sup>3</sup>, and Alejandro Llanganate<sup>3</sup>

<sup>1</sup>Facultad de Psicología, Pontificia Universidad Católica del Ecuador, Ecuador

<sup>2</sup>Facultad de Comunicación, Lingüística y Literatura, Pontificia Universidad Católica del Ecuador, Ecuador

<sup>3</sup>Departamento de Informática y Ciencias de la Computación, Escuela Politécnica Nacional, Quito, Ecuador

<sup>4</sup>Facultad de Ingeniería y Ciencias Aplicadas, Si2Lab, Ingeniería Industrial, Universidad de Las Américas, Quito, 170125, Ecuador

## ABSTRACT

Serious Games have become a popular tool for knowledge transfer, behavioral, perceptual, or cognitive change, and valuable for developing or improving a specific area. The use of serious games for educational purposes can have a very positive effect; in our case, this area is related to the educational or psychological field, and its purpose is to strengthen the psychoeducational processes, allowing the achievement of an optimal and motivating learning process in the different stages of development of the human being. The current research focuses on constructing a serious game for the enhancement of musical skills of children using iPlus methodology. This game is aimed at children from 8 to 12 years old; however, it is not ruled out to be applied to adolescents, middle-aged, and elderly adults. The game is suitable for practicing and improving musical abilities such as memory, attention, and spatial perception by recognizing notes on the staff. The possibility of strengthening two essential psychological processes is also offered, not only for the acquisition of learning but also to solve life problems.

**Keywords:** Serious games, iPlus, Musical stimulation, Education, Gamification

## INTRODUCTION

The evolution of education has taken a radical step from teacher-centered pedagogy to one in which the student is responsible for their learning. In this context, the educational task permanently requires active methodologies that allow the student to arouse interest and motivation to achieve meaningful learning. Incorporating ICTs into the teaching-learning process provides endless possibilities for innovation for both teachers and students. The constant evolution of technology allows education to renew the possibilities of acquiring knowledge, skills, and abilities. Beyond theoretical proposals, the

technology allows students and teachers to open new paths in their need to learn.

This range of possibilities also implies an improvement in the learning scenario. With technology, knowledge acquisition is no longer limited to the classroom space. The experience can be lived from multiple scenarios breaking the old barriers to which educational actors were once subjected. From this situation, the teacher and the student's role is rethought. Similarly, learning and self-learning acquire other advantages and challenges.

Thanks to perception, we interpret external stimuli through our senses. For its part, memory is fundamental; without the acquisition and development of this process, the development of other functions such as language and reasoning would not be possible. Serious games have become a proposal that constitutes an essential tool for learning adapted to the current context. It is a challenge, not directly related to education but to political management, to ensure that all students, regardless of their socio-economic status, can access as many technological means as possibly linked to learning.

This paper presents a conceptual framework, describes the iPlus methodology and the construction of a serious game to the enhancement of musical skills of children, the result of the implementation and evaluation section and finally, the conclusions developed because of the investigation are presented.

## RELATED WORKS

Currently, the study of serious games and their relationship with teaching and learning processes is relevant. In this way, we can mention the work done by (Juca Maldonado, F., García Saltos, M. B., & Burgo Bencomo, 2017) where it is mentioned that serious games are learning tools with didactic, autonomous, self-sufficient, and reusable pedagogical purposes, which allow players to obtain a set of knowledge and competences predominantly practical. For this to be a reality, serious games must be designed to justify their use. In the case of our work, the application has been created to allow the user to learn to recognize the notes of the staff, which also implies the possibility of improving psychological processes such as perception, attention, and memory; in short, strengthening integral learning.

The study (Leyva Regalón and Mayol Céspedes, 2019) researched serious games in training and cognitive rehabilitation, stating that the application of strategies and techniques in cognitive rehabilitation has been supported by using technologies (p.140). In addition, they conclude that, depending on the specific needs of a person, the technologies are applied in various ways, from alarms to remind individuals about their planning of medicines to the use of assistants, robotic, interactive, this strengthens the justification of our proposed research, it also offers a range of possibilities related to the age and conditions of the users. The proposed serious game could be included as part of intervention programs for people with cognitive deficits or in the application of preventive programs to avoid the progressive loss of cognitive processes, as is the case for older adults. However, as (Leyva Regalón and Mayol Céspedes, 2019) conclude, this is a field in constant development that requires many studies.

The intervention of psychological processes through serious games, as psychoeducational resources, allows learning to be improved through a methodology that arouses interest and motivation in the user, who is the builder of his learning with the support of technology built with training purposes. In this case, musical stimulation is added to the playful activity, which is intrinsically attractive to users. The artistic reinforcement thus converts the resource into a promising path for improving the indicated areas.

The development of a serious game must be designed using an appropriate methodology. The player must feel that he is playing a game where the learning is a consequence of the playing actions. The lack of a correct design of the SGs can cause those games to lose both their attraction and their game essence.

Previous studies by the authors (Carrión et al., 2020) argue that applying the user-centered design approach of the iPlus methodology was critical to the development of cognitive skills through temporal sequence resolution and vocabulary review.

Additionally, the authors (Salvador-Ullauri et al., 2020b) argue that serious games have been incorporated into teaching and learning. Due to the increase in their use, the need arises to comprehensively ensure their accessibility to include people with disabilities in educational environments. The results suggest that accessibility should be included in developing serious games based on Web Content Accessibility Guidelines (WCAG) 2.1 (World Wide Web Consortium, 2018) like in the study (Salvador-Ullauri et al., 2020a).

## **DESIGNING A SERIOUS GAME USING iPLUS METHODOLOGY**

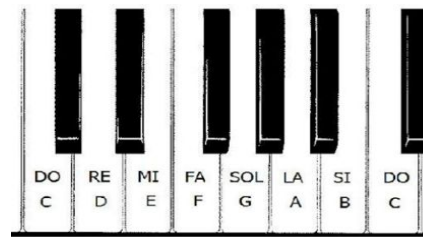
### **A Serious Game to the Enhancement of Musical Skills of Children**

Serious games have shown that it is possible to learn while you play. This teaching method is known as game-based learning; in our case, we use a serious game in the teaching and learning processes regarding music and instruments.

According to (Vargas and María, 2010), the raw material of music is sound, a physiological phenomenon that originates in the inner ear, and its material base is sound vibration. A musical sound has at least four properties: duration, intensity, pitch, and timbre. Musical hearing encompasses at least 3 characteristic domains: sensory, affective and mental hearing. Therefore, training a student in music means stimulating their auditory capacities within the three characteristic domains of musical hearing. For the current project, the iPlus methodology has been used to correctly manage the development of the serious game called “Mozart’s musical adventure,” which aims to improve the musical recognition of notes by stimulating auditory memory through a scenario composed of musicals blocks. These blocks are based on Anglo-Saxon and Spanish-American musical scale notation (see Figure 1).

On the other hand, The project aims to enable the student to recognize the notes of a staff. These notes are related to the basic and sharp scale explained above. In this way, the student can improve his auditory memory and learn the representation of musical notes on the staff. (see Figure 2).

In this document, we explain in a general way the process carried out with the iPlus methodology for the implementation of this serious game, ranging



**Figure 1:** A major Piano scale.



**Figure 2:** Pentagram in treble clef.

from the identification of initial purposes through interviews with interested users and the creation of user stories that are inputs for the implementation of the game in the Unity game engine.

### iPlus Methodology

iPlus (Carrión-Toro et al., 2020) is a user-centered methodology for SG design that presents a participatory approach, offering a phase to ascertain consensual requirements through the participation of various experts.

**Phase 1. Identification:** Resultant artifacts: Here, the general problem is defined by the interested party, and, depending on the situation, participants in the methodology are identified. Description: A serious game is required for the enhancement of musical skills. This study case involves an expert in pedagogy, responsible for defining pedagogical objectives, the product owner, a music specialist teacher, a video game designer, the software developer, and end-users.

**Phase 2. Pedagogical Objectives:** Resultant artifacts: In this phase, the general and specific objectives are defined as participatory and agreed upon under the pedagogical expert's guidance. Description: We interviewed an expert in educational psychology, a child educator and two experts on the subject to better understand how the expert understands the users' needs. An affinity diagram defines the objectives (see Figure 3).

**Phase 3. Ludic Game Script:** Resultant artifacts: This phase aims to create the "Game Design Document" (GDD) based on the Product Owner's needs or requirements. Then, with the selected ideas, the participants and the subject expert create the game script that contains the narrative, characters, and gamification elements such as badges, points, prizes, among others, which can be implemented in the SG. Description: The result of this phase is the game script format or consensual story. In this serious game, it was based on showing how Amadeus (first name of the composer, pianist, conductor, and teacher Wolfgang Amadeus Mozart) seeks to get to give concerts in Vienna

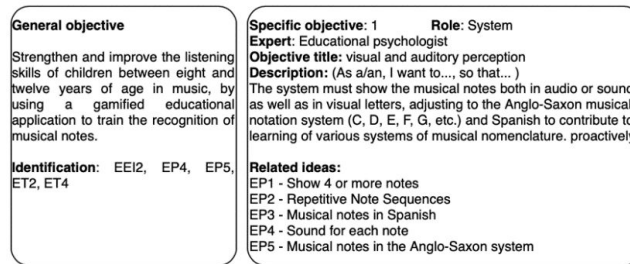


Figure 3: General objective and specific objective.

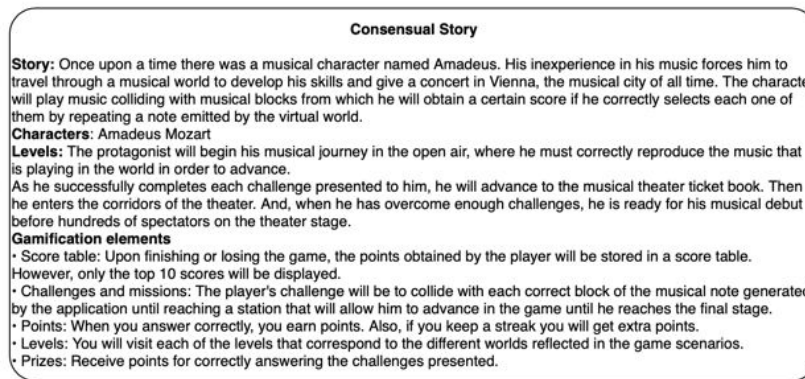


Figure 4: Game script for the serious game.

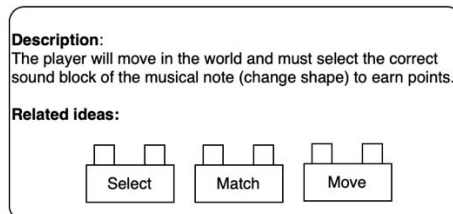
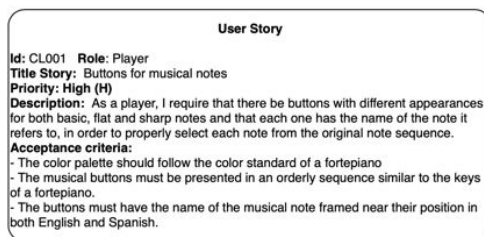


Figure 5: Gameplay card.

through a series of worlds and levels. The following (see Figure 4) summarizes the aspects that allow the reader to have a complete idea of the serious game.

Phase 4. *GamePlay*: Resultant artifacts: Here, experts define the *GamePlay* blocks. They are used to describe the functionalities that are part of the game. Additionally, the genre of the game is identified. *Description*: The *Gameplay* blocks are related to hold, move, position, and points such as “A player wins points when holding, positioning or moving an object. An example of the proposed *Gameplay* blocks is shown (see Figure 5). Additionally, Stakeholders define the game genre as reasoning because it involves problem-solving skills.

Phase 5. *Refine Resultant artifacts*: After going through the ideation process, *GamePlays* need to be filtered to eliminate repetitive or impossible



**Figure 6:** Resultant user story.



**Figure 7:** Game screens.

aspects to create from the pool of ideas. Description: User stories that represent a short description of characteristics of the game expressed as user needs (see Figure 6).

### The Game Implementation

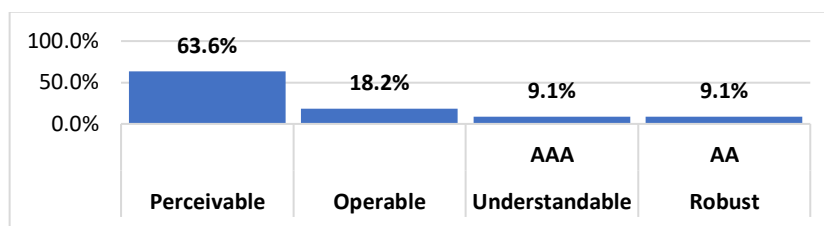
As mentioned above, our case study deals with teaching and learning processes regarding music and instruments, stimulating auditory memory through a scenario composed of musical blocks. The serious game was developed using the Unity cross-platform game engine. The serious game's different interfaces (modules) were implemented. The first consists of the player starting a session by typing a name or alias. Once the player has pressed the enter button, it displays its initial menu. Here, the player can choose between options according to his preferences (see Figure 7 on the left). The first option, "Adventure," allows entering the primary mode of the serious game where the player must pass each level, avoiding mistakes until reaching the end (see Figure 7 right). The "Practice" option allows the player to interact with the different blocks on the screen to practice his ear and remember each marked note's sounds. There is the "Scores" screen where the player can see a board that indicates the names or aliases of the ten players with the highest score obtained so far. In this way, practice is encouraged through healthy competition.

### OUTCOMES AND DISCUSSION

We applied a manual review method of accessibility evaluation based on the four accessibility principles of the Web Content Accessibility Guidelines

**Table 1.** Accessibility barriers.

Id	Barrier	Principle	Success criteria	Level	Compliance
G1	Easy-to-read font	Perceivable	1.1.1	A	1
G2	Text alternatives	Perceivable	1.1.1	A	1
G3	Closed captioning	Perceivable	1.2.4	AA	0
G4	Adjusting display settings	Perceivable	1.3.4	AA	0
G5	Use of color	Perceivable	1.4.1	A	1
G6	Well-spaced elements	Perceivable	1.4.12	A	1
G7	Good audio techniques	Perceivable	1.4.2	A	1
G8	Images as sharp as possible	Perceivable	1.4.5	AA	1
G9	Visual presentation	Perceivable	1.4.8	AAA	1
G10	Accessible keypad	Operable	2.1.1	A	1
G11	Luminance flash	Operable	2.3.1	A	0
G12	Animation of interactions	Operable	2.3.3	AAA	1
G13	Help	Understandable	3.3.5	AAA	1
G14	Consistent navigation	Robust	4.1.3	AA	1

**Figure 8:** Accessibility principles.

(WCAG) 2.1; Table 1 presents the identifier, accessibility barriers, principle, success criteria, level and compliance. The number (1) is applied when it complies with the analyzed barrier, (0) if it does not comply.

From the results, we observe that the accessibility principle that is most complied with is perceivable (63.6%), followed by operable (18.2%), understandable and robust (9.1). Levels A and AA add up to 73.7%, so the application can be considered moderately accessible (see Figure 6). Corrections to the identified barriers will be applied to achieve an accessible and inclusive product in future work.

## CONCLUSION

We suggest applying iPlus methodology, a user-centered methodology for designing Serious Games. It incorporates a participatory, flexible and user-centered approach, adaptable to users with non-standard knowledge. The construction of the Serious Game to improve children's musical skills with iPlus offers a phase for determining consensual requirements through the participation of several experts. The iPlus methodology allows generating more accessible software products so that software development experts can obtain and use user stories as the input to any software methodology.

It should be noted that this application meets most of the guidelines for visually impaired people, including easy-to-read letters, text alternatives, adequate contrast, well-spaced elements, good audio techniques.

We suggest an accessibility evaluation throughout the application development cycle to create usable, accessible, and inclusive applications for future research.

We suggest socializing the iPlus methodology with the software developer community to generate applications that guarantee user satisfaction and start researching new user-centered methodologies.

## ACKNOWLEDGMENT

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