"Professor Piano": a music application for people with intellectual disabilities

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Abstract

In this paper it is presented a music application for people with intellectual disabilities, called "Professor Piano". We created this application to be a solution for music education for this group of people. For that we present the development and implementation of the app. We choose the virtual piano and the mobile devices as the basis for our solution. It was conducted an assessment of the current status and features of mobile applications also using this paradigm, from which we concluded that, currently, there is not a virtual piano application oriented to people with intellectual disabilities so we design, develop and tested a new application, the "Professor Piano".

To validate the "Professor Piano" application approach, we evaluated the application usage by a group of people with intellectual disabilities, without having too much user experience with mobile technologies, with the aim to measure the effectiveness, efficiency and satisfaction. We registered the following variables: success in a conclusion of a level (effectiveness); the percentage of correct notes played versus all notes of that level (efficiency); and the motivation at the end of the experience (satisfaction).

The results obtained shows the interest and motivation of the users in playing with the application. In the four tests, three persons completed and wanted to continue the testing experience. This results also shows the importance of using an intuitive design and also of displaying the score at the end of each level, giving an extra boost to the user to replay or advance to the next level.

DSAI 2016, December 01 - 03, 2016, Vila Real, Portugal

ISBN 978-1-4503-4748-8/16/12 $15.00
DOI: http://dx.doi.org/10.1145/3019943.3019982

CCSTerms

Human Factors; Performance; Music

Keywords

Piano; Usability Evaluation; Intellectual Disability; Android Devices; User Tests

1. INTRODUCTION

Based on current key needs of the audience in their daily activities, such as, studying or being at the computer, it's required to focus on what they are doing to achieve the best outcomes.

Nowadays, there are parents and teachers complaining about the difficulty of the children to focus during classes or to solve a proposed exercise. The music has a positive impact in the development of people, like personal and social development [1], where with active involvement, it can help people to develop life skills such as discipline and concentration [2].

Seeing the problems of children today and for the reason that music can help people in that way, we developed an application to help the users to improve their focus, while keeping them motivated by acting as a serious game with a fun factor [3] using music.

Music has a benefit impact on people with intellectual disabilities, helping improving their social skills [4]. Edutainment systems, including serious games, can improve cognitional and motivational levels on children with intellectual disabilities [5]

Besides the effectiveness of the application in the previously described context, it can also be used by people with other, or no, limitations in order to practice and improve their focus. So, although our main target audience are persons with intellectual disabilities, we also consider a broader public, including specific groups, such as the ones defined by their age or motor disabilities.

This paper is organized in several chapters: "Background", describing the current state of the art, regarding virtual piano mobile applications; "Design and Implementation", explaining how the application works and its main features; "Experimental Design", describing the methods used to test the application, the type of audience, the evaluation variables (effectiveness, efficiency

and users motivation); "Apparatus", describing the devices used to run the application; "Practical Results", describing the test users feedback, and "Conclusion", discussing the evaluation of the results obtained during the field testing.

2. BACKGROUND

A user with cognitive limitations is defined as a person with an Intelligence Quotient (IQ) lower than the population average and with limitations in his daily actions, such as, communication, social interaction and school activities. Despite of their disability, these persons can learn new abilities and skills. However, their development will be slower than a child with an average IQ [6]. Recent studies indicate that the use of technologies, such as, a computer or a tablet, has advantages in the success of the learning process. It raises their motivation, their performance, and it promotes the usage of the Information and Communication Technologies (ICT) [7].

The applications available in the Google Play Store and Apple Store with a piano are just intended for fun recreational usage or to teach how to play the piano instrument. There isn't a specific piano teaching application with the target audience of people with difficulties in attention and concentration.

With no piano application with same goal and target audience, the authors decided to choose and evaluate three piano applications, which have the top scores on Play Store in the piano applications category. They are "Don't Tap the White Tile", "Piano Tiles 2" and "Magic Piano", the former also designated as "or AutoRap by Smule". Although they aren't target to people with intellectual disabilities, they are piano application with a big influence in the mobile market. If an application has a big influence means that the audience like it. So it can be good to evaluate the advantages and disadvantages regarding the usability of them in way to improve our application.

2.1 "Don't Tap the White Tile" application

The "Don't Tap the White Tile" application, presented in Figure 1, has versions for the Android and iOS operating systems and can be used for free. The application has an offline mode and it is available in many languages, like English and Portuguese. Although we can play many different levels, all the available music is classic. The application's design is uninviting and, when in use it displays publicity, like banners and instant videos. It has a good classification in Play Store (4 in 5), in which two hundred thousand users [8] had classified it, although it requires much memory to install in a smartphone (83 Mb).

Figure 1 – Gameplay of "Don't Tap the White Tile"

2.2 "Piano Tiles 2" application

The "Piano Tiles 2" application, displayed in Figure 2, is similar to the "Don't Tap the White Tile" application. In fact, they are both produced by the same company, "Clean Master Games", which promotes "Piano Tiles 2" as the follow-up version of "Don't Tap the White Tile". They both feature an offline mode, free access for the Android and Apple stores and availability in several languages. Regarding the game playing, both applications have many types of different playing levels.

The design has been improved and some new features have been introduced, such as the ability to associate a game to social media, e.g., Facebook, where we can check the rankings. In this application, they had introduced new types of music, although the users have to make a real money transaction, if they want some specific songs. The application requires much memory to install (62 Mb) and had many publicities, while we are using it. Like the previous version, this application has a good classification on Play Store (4, 7 in 5) where more than 4 millions of people had classified it [9] and was one of the best games in 2015 for Play Store [10].

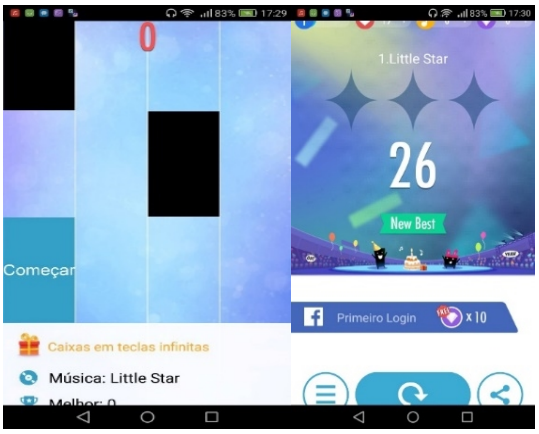

Figure 2 - Gameplay of "Piano Tiles 2"

2.3 "Magic Piano

The "Magic Piano" is quite different from the "Don't Tap the White Tile" and "Piano Tiles 2" in many regards. The user interface doesn't provide a keyboard view and the useful playing area is very small, thus making it difficult to play. The game has many types of music available, but most of them are not free and must be purchase through a real money transaction. The application doesn't have an offline mode and it requires an internet connection. It uses social media to publish and compared the score ranks and it is heavily monetized with publicity displaying. This application has a good classification on Play Store (4 in 5), with more than 800 thousand classifications [11]. Just like the other two applications, it requires much memory to install (90 Mb).

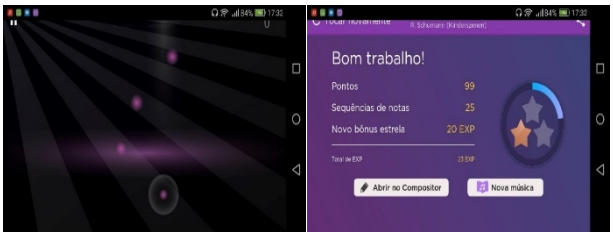

Figure 3 - Gameplay of "Magic Piano (or AutoRap by Smule)"

2.4 Summary

By checking the advantages and disadvantages of the three application, we can evaluate the opportunities and weaknesses to plan and created a new and better one.

The evaluation shows the following disadvantages: the need for high storage to install and run the application; the unattractive design; and the poor user interface. For these reasons, the games are difficult to play and don't fully capture the user attention, which sometimes is also distracted by the publicity displaying.

The games also miss an important point on regarding the piano as the main element of the game. They are incorrectly showing the way of how to use a real piano.

The Table 1 compares the current applications previously described, with the main characteristic missing is the similarity to a real piano.

Applications	Design	Piano similarities	Quantity of Ads	Memory
"Don't Tap the White Tile"	-	-	-	--
"Piano Tiles 2"	++	-	+	-
"Magic Piano"	+	- -	+	- -

Table 1 – Overview of the current applications with a piano (scale from --- to +++)

With this assessment, the authors have extracted a set of requirements to fulfil in the development of the "Professor Piano" application, which main objective is to help people with an attention deficit through the use of a piano playing game.

3. DESIGN AND IMPLEMENTATION

The application was designed according to the previously extracted requirements, namely:

- Have an intuitive and attractive design according to the serious game paradigm [3].
- A simple user interface, with some ease of use customization capability for people with limitations
- A display publicity free application, to retain the user focus;
- Have a user experience as similar as possible to a real piano usage;
- Some minimum apparatus requirements to install and use the application in order to be used by a wide spectrum of devices.

The user interface was designed to be used by people with limitations, so we used well known icons and easy to distinguish colours.

3.1 The implementation

This application was designed to work on Android devices and it has an offline mode. The authors choose to not share the application on social media, to make the application not require much memory (6,27 Mb). The application is free and available at Github [12].

3.2 Using the application

When the user starts the application, has access to the home menu, where it has a button to login [Figure 4]. In the home menu, he can see the application's name, the image and a small description. In case the user need, he can choose the instruction's button, where can see an application's screenshot album, to teach him how to use it. The user can also choose the setting´s button where he can change the hold time of keys, this allows people with motor disabilities to customize the application according to their limitations.

Figure 4 - *Login Menu*

After the user presses the button to login, the application opens a view to give him an opportunity to choose a difficulty level [Figure 5]. The authors have chosen to use "stars" to symbolize the difficulty, in other words, if we want to choose the easiest difficult, we have to choose the button with one star.

Figure 5 - *Difficult menu*

With the difficulty chosen, the user can select a music from that. In this view, he can see the song's name that are available and check him score (if the song wasn´t played yet, the score will be zero). During the choosing of the difficult and music, the user can go back to the previous view.

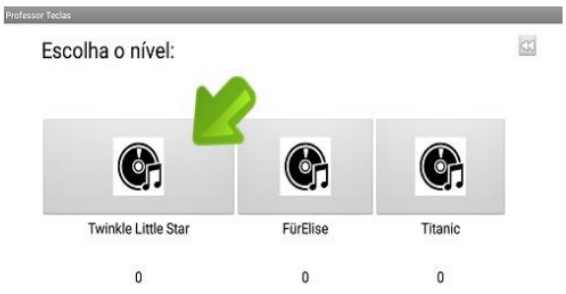

Figure 6 - *Level Menu, where we choose the song*

When the user chooses a music, the system opens the song, showing a piano's keyboard [Figure 7]. The user should select the key with a blue background colour, where a musical note will be display. When we choose the key with the number 1, the musical note will be a "C". The main goal of the application is finish the music hitting all keys, so he will receive the highest score. If the user fails choosing the wrong key, the level will restart to give another opportunity to him.

Figure 7 - *Piano Keyboard View, where we can play*

When the user finishes the music, the system will show him score and he/she can decide if he/she wants to save it or try another time [Figure 8]. If he chooses to save it, the system will save the highest one. The system compares the new one with the last one that was saved in the last game. The percentage score is obtained through the wrong number of keys from that music. When the score is saved, the user can choose if he wants to start another music or change difficulty.

Figure 8 - *End Level Menu*

The "UML State Chart Diagram", presented in Figure 9, summarizes the application usage, describing all the states and important events.

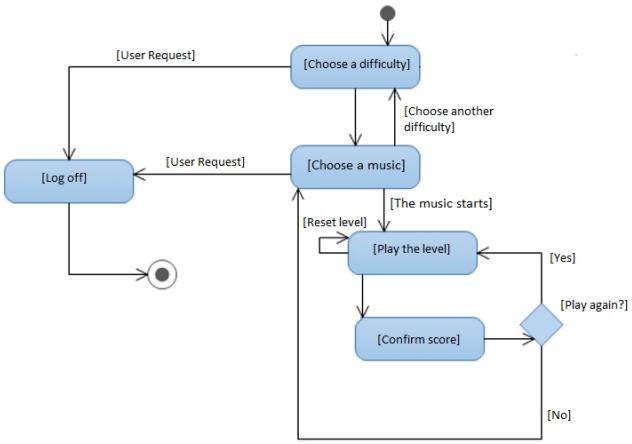

Figure 9 - *State Chart Diagram*

4. USER TESTS

With this user tests, we intended to assess if a group of people with intellectual disabilities can use the proposed application. This preliminary assessment was made to verify if this application can be usable for this group of people, by improving their performance and satisfaction.

4.1 Methods

In this study, the case study was allied to the usability evaluation (user tests) to assess the application.

The case study was used to assess a real application in a real context. The user tests, also known as usability tests, is method used to evaluate the software interaction by allowing a group of participants to interact directly with the system [13]. We assess effectiveness (the capacity to accomplish the proposed task), efficiency (errors, difficulties in the interaction) and satisfaction.

The methods of data collection used were directly related to the methods conducted: pre-test questionnaires, pro-test questionnaires, "think aloud".

The pre-test questionnaire is a technique which gathers background information that can be used when the results of the tests are being analyzed and allows us to have a better understanding of the outcome of results. With this questionnaire we register general information regarding the characterization of the participants (the age, the genre, previous mobile experience and music knowledge).

The pro-test questionnaires, are a type of questionaries' that are used to gather information and recommendations from the tester and gather conclusions about the results [14]. We register: satisfaction (if the user enjoyed to play the songs and if he wanted to continue to play or repeat the songs)

The "think aloud" is a method where is asked to the participant to describe his thoughts during the system usage. In this method the participant doesn't need to be an expert; can proportionate useful information about the system, as we can observe how the system can be used in a real interaction context [15]. With this method we register the user´s difficulties and opinions.

4.2 Participants

The four participants (three man and one woman) that partook in the preliminary study (with ages between 26 and 40 years old). These participants were chosen by a special education teacher at

Nuclisol Institute in Vila Real. Regarding their intellectual disabilities, selected participants weren't restricted by their disability severity, with the purpose to fill in the target public of this study test (people with intellectual disabilities). Two of participants used glasses, all of them didn´t have motor limitations nor hearing limitations and regarding to the education level, the participants didn't know how to read nor how to write. The preferred activities were: music and interacted before with smartphones or tablets, although they didn´t have much experience. They were all volunteers and had written authorizations by their tutor.

4.3 Experimental Design

The participants had to perform two tasks that will be explained in this section.

However, the application had three difficulties modes (: "easy", "intermediate" and "advance") and each difficulty level had three songs, we only test two difficulty levels, in this primary assessment.

The level complexity of the played song was defined with the length of the song, i.e., more piano keys are needed to press to finish the task. As the participant advanced to the next task, the complexity also increases.

Therefore, we established two tasks they had to perform, there were:

T1: play one music in the "easy" level.

T2: play one music in the "intermediate" level

The success criteria of the conclusion task are defined as if the participant was able to complete and correctly finish each task at least one time.

Furthermore, aiming to assess participants' interaction with the application, we register usability evaluation variables: effectiveness (if the user could complete and correctly the two levels); efficiency (compare the percentage of correct notes played versus all notes of that level (errors) and difficulties observed); and satisfaction (if users want to continue to play songs).

4.4 Apparatus

For the user tests, it was used a Tablet (Samsung Galaxy Tab 3 10.1 P5210). We choose this Tablet with a large screen (10-inch screen size), because we believed it could be easier for the user to interact with the menu buttons and piano keys.

4.5 Procedures

First, we invited the participants to sit down, in front of them they had a Tablet to perform the tasks with the application launched. Then, the observer/ evaluator explained to the participant how the application works. After that, the participants interact without help. They had to: click in the start button, then choose the difficulty level (we indicate they had to start with the "easy" level), choose the music they wanted to play and then play the song chosen.

If the users/participants had difficulties in the any stage of the interaction the observer/evaluator helped and this information was register.

After they play each song, the score (percentage of correct notes played versus all notes of that level) was shown to the user. Also, after finishing the tasks, participants could select another music or difficulty level.

At any time, the participant could drop out the task.

4.6 Results

The results are presented according to the variables of the user tests: effectiveness, efficiency and satisfaction.

First, effectiveness, in which we verify the user success in the level conclusion, each user had to play at least one song in "easy" level easy and another song in "intermediate" level. In both tasks, the participant 1 gave up and the others participants completed with success.

Regarding efficiency, we verify the percentage of correct notes played versus all notes of the music chosen by the users in both tasks. Thus we register: in task 1, participant 1 had 0% score, participant 2 had 92% score, participant 3 had 100% score and participant 4 had 72% score; in task 2, the participant 1 had 0% score and the others participant completed with 100% score.

Figure 10 shows the user tests percentage of key notes correctly played, which is obtained from the keys correctly played divided by the number of keys in the song (this is calculated automatically by the application and shown to the participant when he/she conclude playing the song, it is demonstrated in Figure 7).

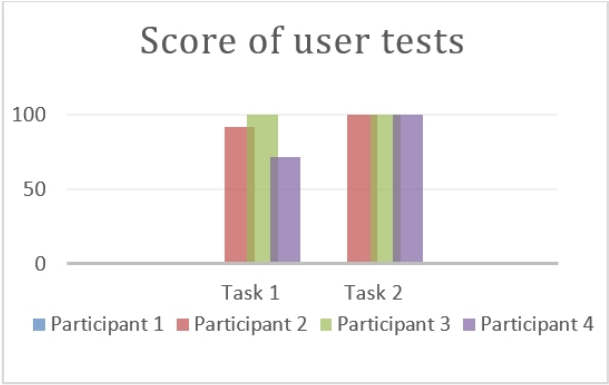

Figure 10: Score of user tests tasks in percentage (%)

In figure 10, we register an improving in the interaction between the two tasks (tasks 1: song in "easy level", task 2: song in "intermediate level") of participant 2 and participant 4. We believe they improved their gameplay skills, and could indicate a major concentration in the game.

For efficiency, time was not measured because users could choose which music prefer, increasing the number of piano keys that needed to be pressed.

However, we register difficulties felt by participants in the use of the application. Participant 1 showed many difficulties in interact with the different menus, such as: login menu, difficulty menu (where they chose the difficulty) and level menu (where they choose the song). Also, he had showed difficulties on playing two songs as defined in the proposed tasks leading him/her to drop out. Participant 2 demonstrated difficulties in interact with the menus but during the proposed tasks he/she showed interest on the activity and improved his/her performance. Participant 3 had no difficulty in the two tasks and interacting with the application menus. Participant 4 had difficulties in interacting with the applications menus and, in the first task, he started by trying all piano keys before playing, the participant showed signs of improvement in the second task finishing without any difficulty in choosing the right piano key (the one with blue background color).

Regarding errors, we register: participant 1, clicked on 13 incorrect keys and drop out; participant 2, in three keys; participant 3 did not made errors and participant 4, clicked on 11 incorrect keys.

Another observation register was concerning their strategies for learning how to play correctly the songs. Participant 1, 2 and 4 started to play instead of trying the interface first. In contrast to these participants, participant 3 had a different learning strategy, he had started by trying multiple keys, before playing. This fact, highlight the no errors result by this participant.

Concerning satisfaction, we verified that three participants wanted to play more than one song after the tasks conclusion, this could indicate that they were motivated to use the application. From the 4 participants, 3 participants (participant 2, 3 and 4) said that liked it and wanted to try more levels. Specifically, participant 2 and 4 tried another song in "easy level" and participant 3 wanted to try two more songs in "easy level" and one more in "intermediate level". Only participant 1, did not wanted to try another level or song. We believe this happened because he/she failed in the first task and in the second task he/she did not wanted to continue, he/she seemed to be disappointed with not having a good performance in the tasks and this led to the drop out and a disinterest regarding the application usage.

5. CONCLUSION

In this paper, we presented a music android application to be a solution for music education for this group of people. Users can choose music in three levels of difficulty (easy, intermediate and advance), play the song by clicking in the pre-determined keys to achieve the highest score.

The results indicated that the application can be used with this group of people (because they overtake some problems of interaction, with one exception - Participant 1) and it seemed to retain user attention and interest. Users that accomplish successfully the proposed tasks kept motivated to continue to other songs and levels of difficulty. This fact indicates that they can retain concentration and had motivation to improve their performance

with the application.

Globally, the obtained results indicate that most of the users were able to accomplish successfully the proposed tasks.

For future work, we intend to increase the participants of the usability assessment, also test with children and the elderly, with the main purpose to gather more data to assess what features we could add to this application that can be used to improve the music learning of people with intellectual disabilities digital abilities.

6. ACKNOWLEDGMENTS

This paper was supported by the project entitled "Metáfora de interação acessível para navegação Web sem recurso a texto", financed by the Portuguese Science and Technology Foundation, with an eligible investment of 21.500,00€.

Also, we would like to thank all personal of Nuclisol Jean Piaget Institute at Vila Real, for their availability and sympathy. Also, we would like to acknowledge the developer of the open code presented in GitHub platform that was used partially and served as inspiration.

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