USING SERIOUS GAMES IN DYSLEXIA TREATMENT

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ABSTRACT
Dyslexia is a disorder which affects language and writing skills, remaining of crucial importance to undertake an appropriate diagnosis and treatment to avoid subsequent problems. Nowadays, there are not many tools in the market which use serious games for the treatment of this disorder. Experts use tests in their therapies but they lack the possibility of measuring important parameters such as response time or user’s errors. By means of this innovative work a platform adapted to professionals as well as to people with dyslexia is shown, thanks to which people suffering from dyslexia are able to exercise, work and improve the skills they face difficulties in, through an easy and enjoyable way. Besides, it provides those responsible with a support in which the results the participants have been obtained along the games are registered, thus being able to check the evolution and the progress of those. In this very first stage encouraging results were obtained, to be able to continue widening the platform by proving the improvement the participants experienced.

KEY WORDS
Dyslexia treatment, serious games, client/server model, attention improvement

1. Introduction

Dyslexia is a disorder that affects language and writing, as well as the understanding of both the former and the latter [1].

According to studies conducted, 5%-10% of children are affected by dyslexia, and, more especially boys. [2]. Those Children use to have problems in the school environment, like, for example in those subjects in which they are required to express written ideas or simply when taking notes [3].

For the people to cope with these problems, it remains of great importance to undertake early diagnosis and intervention, since thanks to this it is achieved to reduce the negative impact in the psychosocial development, and hence, avoid possible psychiatric problems such as depression [4].

Various exercises are used by professionals/psychologists for treatment [5] in the field of dyslexia, such as matrixes of letters [6-7] or the selection of a letter between a set of similar letters [8-9]. This exercises present limitations on storing certain information such as the exact time the user takes to respond and their successes and failures, thus forcing the experts to spend a lot of time measuring and recording these parameters. In addition, relying only in these methods makes monitoring more difficult.

The author in the literature found a great number of tools which are used in the field of dyslexia treatment [10-11-]. However, these tools present some problems. For although parents/teachers/children can access to web sites containing exercises to improve dyslexia [12], these web sites do not allow to make an exhaustive monitoring of children sessions.

An alternative to this problem can be the use of the so-called Serious games. Serious games are currently playing an important role in society and are becoming increasingly used in different fields, such as health, education and even in therapies [13] helping people to overcome a particular physical or psychological problem [14]. It has been proved in various studies that better results are obtained through these games, which is explained by the fact that users enjoy themselves and concentrate better on the exercises they have to do, forgetting that they are actually taking part in, for example, a therapeutic or rehabilitation process [15].

However, as there are very few games [16-17] oriented towards the treatment of this particular disorder, this research work intends to demonstrate the efficiency of a new form of treatment with these new and more widely used serious games.

This paper presents the goals achieved up to now with this project:

- To provide a game-based tool for the efficient treatment of dyslexia.
- To demonstrate the efficiency of new platforms in the treatment of dyslexia.
- To provide a tool which is accessible to users at any time.
- To add the detailed monitoring of users’ improvement in a straightforward way.
- To carry out final validation with user tests.

The serious games developed on this web platform are aimed at children at reading age, i.e. between 6 and 8
years old. According to other studies carried out, it has been demonstrated that it is important to detect dyslexia at an early age so that the children can participate in treatment therapies in which they can acquire and exercise their reading and writing skills, which will therefore improve notably [18]. Thus, the aim is to treat dyslexia in the initial reading years, so as to prevent academic failure caused by a lack of prompt treatment.

This paper is divided into the following main sections: Section 2 describes the proposed system, section 3 describes the technical and social results, and section 4 explains the conclusions reached.

2. Proposed System

This section focuses on the design of the proposed system.

A multidisciplinary team composed of a psychologist, an engineer and a doctor collaborated in this project. All of them were involved with the project throughout its development and trials.

The developed tool follows three-layer client/server architecture (see Figure 2).

- The Data Base Layer stores data related to the games and their users.
- The function of the Web Service is to connect the data base with the interface layer. As a result, it is possible to modulate the system, paving the way for future extensions that allow greater scalability.
- The Interface Layer is responsible for displaying the users, games and similar data, as well as collecting and sending the data gathered by the application throughout the playing of the different games.

2. Example Section

The game which users have to complete is introduced in this section. For this purpose, an example of how the exercise should be done is provided.

2. Practice Section

In order to ensure that the user has understood the aim of the game and has assimilated how it is to be completed, there is a practice run before accessing the exercise itself. Once this practice run has been successfully carried out, the user moves on to the exercise section.

3. Game Section

In this section the users test their skills. They have to play through the different levels comprising each exercise. Every time a level is completed, it is checked whether the user has given the right answer. If so, the next series is displayed, and if not, the user repeats that level. The game levels become more and more complicated each time the user completes three consecutive series correctly. Therefore, if the user is not able to respond correctly, the same level will be maintained (see Figure 1).

The series used in each exercise are repeated for each child taking part and were previously chosen by the psychologist and the doctor participating in the project. It is therefore possible to carry out an objective comparison and assessment of the results.

3. Results

The technical results obtained after having followed the methodology explained in the previous section are described in this chapter as well as the social results obtained up to the present.

Until this moment, the platform is implemented in Spanish and Basque languages, due to the fact that they are the mother tongue of the users who have participated in the test.

Due to the fact that the research the author presents about the developed games to use them in therapies and prove their impact is in the preliminary stages, the project involved the collaboration of 10 children with dislexia between 6 and 8 years old (see Figure 5).
The children who have participated in tests of the platform are children who attend consultations of the psychologists who participated in the design of the exercises.

As the participants are under-age, a written authorization of the children’s parents/ tutors was required.

3.1 Technical results

The resulting platform includes a series of games to be used in the therapeutic treatment of dyslexia. The designed games always have the same structure as this leads to greater concentration from the part of the user and easier assimilation of how the games work.

These games are developed to be always performed in the presence of the expert/psychologist/family member, who will be responsible of explaining what the game consists of and how should it be done to the user.

As it was mentioned in the previous section, the games were divided into: example, practice and exercise. All sections have a similar appearance (see Figure 3).

![Figure 1. Game structure](image)

1. Game instructions for experts.

The instructions intended for the expert appear on the right hand side of the screen. They indicate the aim of the game, how should the user approach the game and whether it is necessary to switch on the microphone or not.

2. Game instructions for users.

The name of the game about to be played and the instructions for the children are at the top of the screen. A clear and concise explanation of the game is given. Depending on whether the child is doing the example, practice or exercise section, different instructions will be displayed: the child will be instructed what to do in the example section, the child is encouraged to have a go in the practice section and finally, in the exercise section they are told that the game is going to begin so they should concentrate.

3. Game section.

The central part of the screen is where the games are played. In this section, the child interacts with the tool. On the left is a sound/volume icon; this is because in some games the child has to play or choose a series of audios. Therefore, if they need to repeat an audio sequence, this option is available with this icon.

Below are examples of the games comprising the treatment area of the application (see Figure 4).

- **Syllable Memory**
  
  This game consists of listening to different groups of syllables which the child then has to choose in the same order that they have been voiced, from a group containing a greater number of syllables (see Figure 4-A). The levels of the game get more and more complicated as the child responds correctly; i.e., at the first level the child has to select two syllables in the right order from the group of three that are shown. In order to progress to the next level, he/she has to get three different series right consecutively. When the answer is wrong, the right answer is given and the child continues to do the same series until he/she answers correctly. When the child is right three times consecutively, he/she proceeds to the next level, each of which is made more and more complicated by adding an extra syllable to be selected in the right order until reaching the last level of six syllables.

- **Fill the gaps**

  In order to pass this game, the user has to fill the gap in the sentence with the options that are shown in the screen (see Figure 4-B). As the user passes series, the difficulty of the exercise increases. First, users have to complete the sentence with syllables, secondly they have to complete the sentence with pronouns, prepositions, and finally, the last level is related to punctuation marks.

- **Guess the picture from phonological track**

  This game consists of relating a syllable with an image (see Figure 4-C). For this, the users listen a syllable corresponding to the end of the name of one of the images that the system shows. The users have to answer quickly and in the correct way to continue with the series. In case of failure, users have the option to repeat the series.

- **Repeated words**

  This exercise shows the user a list formed by two columns of similar words (see Figure 4-D). Only two of these words are well written and are identical. The user should be able to recognize this pair of words. If the user does not respond correctly, the system gives users the option to repeat. Through this exercise the reading capacity of the child is improved.

  Through this game, the grammar and language understanding are trained.

  As this game is more complicated, it is oriented to children with slightly accentuated dyslexia.
3.2 Social Results

To comprehend how the social results were obtained, it is considered of great importance to describe the guidelines followed in the first place. For this reason, this section has been divided into two subsections. First of all the experiment carried out is described and, secondly the objective results obtained are shown.

3.2.1 Description of the experiment

The psychologist along with his team has used 20 minute therapy session to perform the exercises with the children, encouraging them through various awards as they overcome them. The experts decide what type of awards given to each child, such as candy, coins, etc.... depending on what motivates them. Through these awards, the children compete with each other, getting to keep them attentive to the exercises and improving in order to surpass their teammates.

In addition to carry out the games in therapies collectively, the users undertook small competitions among the children participating. The time spent in this kind of therapy has been variable since it has relied on the time spent by the children in completing the exercises.

Thanks to that competitions, children check themselves the way they improve, and, above all, a special motivation to continue working and increase the attention time in the exercise is created.

To create the competition scenarios, the experts followed some guidelines:

1. Two children with similar grade of dyslexia were chosen.
2. Children sat one in front of the other
3. When children were ready, games started at the same time. Both children had to complete the exercises / games with the same series and with the similar order appearance. This fact allows experts to assess them in an objective way.
4. As items were completed, experts give awards to children
5. When the game was finished experts should explain errors to children and mention the winner. The winner is the first child who completes the game with the least number of attempts.

3.2.2 Objective results

In first competitions, children used to complete games quickly but without paying attention and failing most of the series. Hereafter, a table (see table 1) with the results obtained by one child in “Guess the picture from phonological track” is shown and the results of the competition as an example (see table 2).
As we can observe the child has completed the game with a great number of attempts. He has made an average of 3.5 attempts per series.

In the final results shown in table 2, it can be verified that various attempts within a very short time for each series have been carried out (An average time of 45 seconds per each series for children without dyslexia is established).

This is due to the fact that in the first competitions carried out, children answered with the intention of finishing in the first place and not with the intention of making the exercise correctly.

Table 2. Example of results of competition

<table>
<thead>
<tr>
<th>Games</th>
<th>Time for games</th>
<th>Average of number of attempts per serie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllable Memory</td>
<td>15.4 min</td>
<td>4.7</td>
</tr>
<tr>
<td>Guess the picture from phonological track</td>
<td>10.16 min</td>
<td>2.4</td>
</tr>
<tr>
<td>Repeated words</td>
<td>14.6 min</td>
<td>4.2</td>
</tr>
<tr>
<td>Fill the gaps</td>
<td>13.5 min</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Nevertheless, the number of average attempts per each series as the child works in therapies and competitions is reduced. (see tabla 3), thus observing a great evolution.

The way chosen to assess the system and user satisfaction was that of a set of questions adapted to the characteristics of the project. On the one hand, each participant was asked a total of six questions and to rate a particular feature on a scale of 1 to 10 (1 being strongly disagree and 10 being strongly agree):

- Q1: Do you think this new treatment is attractive?
- Q2: Is this application intuitive?
- Q3: Are levels complicated?
- Q4: Is the speed of series appropriate?
- Q5: Are instructions clearly presented?

These questions were defined with the collaboration of the psychologists who worked during all the research, with the aim of getting to acquaint the satisfaction of the users with dyslexia. As it can be appreciated in Figure 6, the average results obtained for each question scored between 6 and 8.5 points. The highest scores were obtained for question 1 which corresponds to whether they consider this new form of treatment attractive.

Figure 6. Average result

On the other hand a satisfaction survey about the environment of the generated reports, the information shown in those, and whether they observed an improvement in the children participating was conducted to those responsible. The experts answered to the questions, remarking as one of the advantages the platform presents the possibility to check the evolution of the children in a straightforward way, maintaining an objective register of their progress. In addition, they indicated that they noticed an improvement in the...
children’s reading-writing skills (See the example in Table 3).
They have also observed a greater attention from the children when they play the games of the platform, that has allowed them to improve in a significant way.

4. Conclusion

The question we try to answer with the proposed platform is: Could Serious Games Improve the Dyslexia Treatment?

In this article, a first research about how serious games adapted to the needs and to the abilities of the children suffering from dyslexia can help to achieve children to work and improve both the attention and the reading-writing skills affected by this deficit while they enjoy.

Furthermore, this type of exercises were generally accepted by the children participating, showing a great interest in games and the way of working with them. This is due to the fact that the children are more focused and forget that they are in therapy.

Despite the fact that the sample is not very numerous, good results were obtained. Hence, we are about to continue performing tests in schools and various associations and we shall also continue with the internationalization of the platform.

Games have demonstrated to be a suitable complement for experts during the treatment of this disorder. However, it is important to emphasize that games need to be adapted to each treated area and age of the target users.

After analyzing the results, the author concludes that the games-based tools are a good solution for the improvement and treatment of skills affected by dyslexia.

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