LEARNING HOW TO USE A QWERTY KEYBOARD WITH A GAME INTERFACE FOR CHILDREN: A USABILITY PRELIMINARY STUDY

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Abstract

In this paper, a game interface for children with learning difficulties designed to enable learning and training the interaction with a QWERTY keyboard, therefore enhancing digital literacy and inclusion, is presented. Specifically, the interface presented writing activities with several difficulty levels, from monosyllabic to polysyllabic words, allowing the training with the QWERTY Keyboard. To assess usability of the interface we performed a preliminary user test with ten children with learning disabilities and it was register the following usability variables: efficiency, effectiveness and satisfaction. The main results showed that children improved their performance with the keyboard throughout the activities but showed spelling difficulties in higher difficulty levels. These difficulties were not in interaction with the QWERTY keyboard but in the word spelling. Still, all conclude tasks with success, no one dropout.

Keywords: Serious Games, QWERTY keyboard, Children with learning disabilities, User tests, Digital Literacy and Inclusion.

1 INTRODUCTION

We are living in a technological era, new generations born surrounded by technology, from digital and virtual reality to our mobile phones that function as small computers. However, the used form of input information, still remains through devices such as the QWERTY keyboard. The QWERTY Keyboard is an input device often used, even if it is presented as virtual keyboards, in tablets, iPads and smartphones. However, the user interaction complexity is high and is confirmed in several studies [1] [2] [3]. Therefore, it is important to learn how to interact with this tool and train how to handle it by identifying the positions of the keys and its features [3].

Furthermore, to handle the QWERTY Keyboard is necessary to have writing abilities. The writing ability is key for interaction with this device, as can allow to execute ordinary digital activities otherwise difficult to perform, such as: sending an email, writing a post on social media, search for web content, create presentations and interact with web pages.

Specifically, there are groups with learning disabilities with numerous problems on writing and reading activity, such as children with dyslexia. The International Dyslexia Association (IDA) defines Dyslexia as "a specific learning disability that has a neurobiological origin" [4]. People with dyslexia have "irregular links between two regions of the brain and have to rely on alternative brain circuits to read" [5]. Thus, a person with this disability may experience difficulties with accuracy and/or fluency in recognition of words and have reduced spelling and decoding abilities [4] [6]. These difficulties can be detrimental to young students in their school career as it can affect their understanding of reading, which can lead to demotivation, thus creating important vocabulary deficits, for example in writing [5].

For this group, the interaction with the QWERTY Keyboard seems difficult to achieve, as it demands abilities in writing and this can be an obstacle that needs to be overcome.

Several studies highlight the importance to train and perform reading and writing activities so that people with learning disabilities can find solutions to overcome the problems they face. Also, stated digital environments can be ideal to make this training and apprenticeship. As an example, Wanderman confirmed writing with pen and paper is so difficult that it is hard to enjoy the process, so people with learning disabilities avoid doing so, concluding that improvements of their writing skills are non-existent due to the lack of practice [7]. Furthermore, the author commented his own experience, "if he had practiced more with paper and pen than his writing skills would have improved, but it was through the keyboard that he eliminated dysgraphia, because he could make changes to his texts and perform a review printed on the screen" [7].
Hence, in this paper, a game interface for children with learning difficulties designed to enable learning and training the interaction with a QWERTY keyboard, therefore enhancing digital literacy and inclusion, is presented. Specifically, the interface presents writing activities with several difficulty levels, from monosyllabic to polysyllabic words, allowing the training of the interaction with the QWERTY Keyboard. Developed with a user-centred design philosophy, a clear-cut design and usable layout, this game made in Flash, allowed children to practice writing words using the Qwerty Keyboard, providing positive feedback regarding the wrong or right input. Also, it was intended that the focus of the children did not fade and maintain the motivation to keep training and using the interface. With this objective in mind, the interface was developed as a serious game, children can learn how to write with a QWERTY Keyboard by playing in several levels, unlocking different writing contents (with several degrees of complexity: words/paragraphs).

2 METHODOLOGY
In this research, it was intended to present a game that allowed children with learning difficulties to train their spelling of simple or complex words using a QWERTY keyboard. The solution presented was developed with a user-centered design philosophy, clear-cut design and usable layout. After design and implementation, we performed a preliminary usability assessment to register problems of interaction.

Regarding the assessment criteria, we followed the variables of usability evaluation (effectiveness, efficiency and satisfaction) to assess user performance and experience. As for effectiveness, we registered how many participants performed the tasks with success and without giving up. In efficiency, we registered resources spent to achieve effectiveness: time to perform the task and difficulties observed. In satisfaction, we observed if the participants showed comfort when performing tasks and if they asked to repeat the tasks.

The methods of data collection used are directly related to the research method adopted and include: logbooks, direct observation and user tests, previews described.

3 THE CLOUD - SOLUTION PRESENTATION AND ASSESSMENT
Next, the solution interface development is presented, regarding design, implementation and assessment

3.1 Interface development
Our inspiration came from a game that was released by Triband, which is called Keyboard Sports [8]. Also we took in consideration the principles principles of the Dyslexia Style Guide [9] in combination with Web the Accessibility Content Guidelines [10] for the design and implementation of the solution presented.

3.1.1 Design: stimulating interaction
It was defined as mandatory to present an interactive keyboard for the children that provided a positive feedback whenever they succeeded in spelling a word, or whenever they missed, in order to stimulate them to replay and reintroduce the correct character, without giving up, and promoting training to overcome reading and writing difficulties (Fig.1).

![Figure 1: Game interface evolution.](image)

With these requirements in mind, we established to create a serious game, with multimedia feedback, through several graphic elements: text, image, color and sound feedback. The first step was to design
taking into account the principles of the Dyslexia Style Guide [9] in combination with Web the Accessibility Content Guidelines [10]. Therefore, it was decided the following graphical features:

- **Blue background color.** The BDA determined several principles that influence our choice: “avoid green, red and pink, problematic colors for people with color blindness”; “Use of single color backgrounds. Avoid background patterns or pictures and distracting surround”.
- “Use readable fonts, sans serif fonts, as letters can appear less crowded and Font size should be 12-14 point or equivalent (e.g. 1-1.2em / 16-19 px).” We used Helvetica font, with font size of 13 point.
- We used bold for emphasis the character to be insert.
- “Use headings and styles to create consistent structure to help people navigate through content”. We presented the same information (level, word counting and points, image) in the same space and frame in all game interface to be consistent.
- Also, we used sufficient contrast colors levels between background and text.

Regarding interaction and feedback provided:

- The game interface presented an initial menu with only one button: “Play”. With this button, the player could start the game. Five levels of difficulties were presented, each difficulty level correspond to a word length, monosyllabic or polysyllabic words.
- The main character of the game was a cloud that walks on the keyboard as players click on the correct keys, showing a lightning whenever a word was misspelled or a rainbow if the spelling was correct.
- Once again, according to the Dyslexia Style Guide, it was necessary to “give instructions in a clear and simple way”; so in the main screen, we described the purpose of the game with simple instructions.

### 3.1.2 Implementation: facilitating interaction

To design the graphical elements it was used Adobe Illustrator and to implement the game’s interface we used programming language Action Script 3.0 in Adobe Flash CS6, aiming to animate graphic elements and making the game’s interface more accessible and functional.

### 3.2 Interface assessment

The usability of the game interface was assessed with real users throughout direct observation and users tests. Therefore, we recorded the following usability variables: effectiveness, efficiency and satisfaction. The characterization of the participants, procedures, apparatus, results and discussion are presented next.

#### 3.2.1 Participants: Who participate?

Ten children were invited to participate in the preliminary usability assessment. These ten children, between 8 to 11 years old, were students from two Portuguese primary schools. In the first school, we had six children, four girls, in the 3rd year and two boys, in the 4th year. In the second school, four children participated, three girls and one boy, all in the 4th year of schooling.

Also within the group, eight participants had normal vision and two had corrected to normal vision. All participants were volunteers and had permission of their parents or tutors to participate in this study.

![Figure 2: Participants playing with our game.](image)
3.2.2 Procedures: How we did?

Two teachers, one responsible teacher and a special education teacher, were invited to observe the assessment process.

Before starting any experiment, it was necessary to create an informal relation with the children to allow them to feel relaxed and comfort. After this first interaction, we explained, in detail, what the game would consist on. After this explanation, we asked the children to start giving their feedback about the interaction while they were playing. The tests were conducted in the classroom but individually. Participants were seated correctly in front of the screen.

The evaluation tasks were defined as follows:

- Each task corresponds to a difficulty level.
- Participants need to try three difficulty levels:
  - Level 1 – words with one syllable;
  - Level 2 - words with two syllables;
  - Level 3 - words with more than 3 syllables.

- At each level, the children experienced three different words, in Portuguese, in total:
  - Level 1 (PAI, MAR, NOZ).
  - Level 2 (RATO, GARFO, MULHER).
  - Level 3 (MACACO, TECLADO, SURPRESA).

- The success criteria was to recognize and replicate the written words correctly.

3.2.3 Apparatus: Which material was used?

For this assessment, we used a computer, a computer MacBook Pro 2012, with 13". The game was executable in Flash, and it was necessary the use of an application called Wine to be able to perform the tests through the computer.

3.2.4 Results and discussion: What information was obtained?

Overall, most of the children (8) did not have interaction problems with game’s interface. They focused on the words whenever they appeared and wrote them without hesitation and after a first interaction did not use the audio help. They stated the game interface and task definition was easy to interact and understand. Also, they affirmed that liked the image representing the word presented, in the right corner of the game’s interface.

At the end of the game, they wanted to repeat and said they liked it.

Despite these positive feedback, we had two children that showed some difficulties, which we need to highlight. One had difficulties because instead of recognize the characters, he/she tried to memorize the word and rewrite it. This situation increased one’s level of stress but he/she did not wanted to dropout. It was observed that he/she had to focus on words so she could recognize each letter. Despite this situation, he/she affirmed that liked the game and wanted to repeat.

Another participant, misspelled several words by exchanging the characters, but said that he/she felt motivated to complete the tasks defined because of the positive feedback provided by the main character of the game, an animated cloud that walks on the keyboard as players clicked on the correct keys, showing a lightning whenever a word was misspelled and a rainbow if correct spelling.

Specifically, in regard of effectiveness, all participants conclude the tasks with success and no one wanted to quit.

Next, we describe effectiveness by describing the levels and the words that children had more difficulties. Participants experiment three difficulty levels, level 1 (words with one syllable); level 2 (words with two syllables); and, level 3 (words with more than 3 syllables).

In level 1 (PAI, MAR, NOZ), participants did not have any difficulties or made any misspelling and conclude the task in an average time of 5.3 seconds.

Specifically, in level 2 (RATO, GARFO, MULHER), in the first word, RATO, they did not have any difficulty, however in the second word, GARFO, they showed some difficulties with the position of the
characters, they wrote GRAFO but after some attempts they conclude the task with success. Participants took 6 to 15 seconds to write this word correctly. Also, in the third word, MULHER, some participants, missspelled the positions of the L and M characters. They took an average time of 31 seconds to write this word and complete the level.

In level 3 (MACACO, TECLADO, SURPRESA), in the first word, MACACO, they did not showed any difficulty. But two participants had difficulties with the second word, TECLADO, although, after some attempts, they concluded the task with success. Participants took 8 to 35 seconds to complete the task. The last word, SURPRESA, some participants, missspelled the positions of the R character. Yet, they took 10.5 to 40 seconds to write this word and complete the level.

All participants liked to play and eight asked to repeat the game. Overall, the results were positive, although we verified that two participants had more problems than the others.

However, they completed all levels and tasks successfully. The goal was to practice writing words using the QWERTY keyboard so that this device can help them to avoid mistakes in writing. It was found that during the tests, the interaction with the keyboard was easier for them. They described as key features for a good interaction: the use of a key underline color helped them in writing words correctly; the image provided at the top page, right side, representing the word; and, also the sound feature provided.

4 CONCLUSIONS

To assess usability, we perform a preliminary user test with ten children with learning disabilities and register the following variables: efficiency, effectiveness and satisfaction. The main results of this assessment showed that children improved their interaction throughout the difficulty levels. The difficulties observed were not in interaction with the QWERTY keyboard but in the word spelling. Still, all concluded the tasks with success and no one dropout.

Furthermore, key features were highlighted: the use of the color emphasizing the key of the keyboard and corresponding the character to be insert, was confirmed as an excellent help in writing; presenting an image at the top of the interface/ right side, as a graphical representation of the word; and, also the sound feature provided. Participants also gave a positive feedback regarding the main character – the Cloud – they affirmed that the “friendly element” was a helpful assistance for identifying correct or incorrect spelling and also to motivate them to try again.

As future work, it is intended to create more difficulty levels, adding the possibility to create phrases and other writing exercises, for different users' profile (as example: dyslexia, dysgraphia). Similarly, we want to perform more user tests and apply other usability and accessibility assessment methods to provide a full evaluation.

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REFERENCES


