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# Phonological Disorders in Children? Design and user experience evaluation of a mobile serious game approach

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**Abstract**

This paper presents the concept and the user evaluation study of the first Super-Fon's prototype, which is a mobile health app with a serious game approach for Android Tablets. It was developed with the main goal of working as a complement to the therapeutic intervention in phonological disorders in children between 3 and 8 years old. The app comprises a range of activities, grouped into levels, presenting a therapeutic intervention that follows the Metaphon methodology. The serious game dimension was added to better engage children in its use. The paper presents a user study conducted with two groups of children, without and with the phonological disorders. The first one worked as a control group to better help finding out if the prototype is well designed and provides a positive user experience to be well received by the children, engaging them, despite their condition. The results of the study were very positive and promising.


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*Keywords:* Mobile health; speech-language therapy; metaphon methodology; HCI; gamification; serious games; phonological disorders

## 1. Introduction and Background

The use of computer technologies in Speech Language Therapy (SLT) is becoming common. Moreover, positive results can be found in the treatment of phonological disorders in children[1]. On the other hand, in the last decade, we witnessed an explosion in the use of mobile technology among young children[2]. Mobile health (mHealth) apps are tools that support patient-centered models of healthcare by enhancing patient involvement and self-management capabilities[3]. Moreover, intervention with children should follow therapeutic strategies based on the use of pictures

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and games in general, working in a playful manner, in order to make it, besides stimulating, interesting to the children[1]. Serious games based therapy (theragames) is currently gaining a lot of interest by the healthcare community[4]. These solutions make use of game mechanics and design techniques to improve the user experience and user engagement[5].

The project Super-Fon[6] was designed to complement the therapeutic intervention in phonological disorders in children between 3 and 8 years old. Super-Fon is a mHealth app with a serious game approach based on the Metaphon therapy[7]. A metaphonological approach develop and use children's phonological awareness to make changes in speech. Metaphon is based on metalinguistic tasks, such as homophony confrontation. This methodology is composed of two phases. Phase one allows children to play and learn about sound properties, which enables children to transfer that knowledge to a real communicative environment[8]. This phase presents four different levels: 1-Concept; 2-Sound; 3-Phoneme; 4-Word. Children can only go to the next level when the previous one is acquired[7]. The main objective of phase two is to develop metaphonological and metacommunicative awareness in the child, presenting three main objectives: 1) transfer the metaphonological knowledge obtained during therapy in the previous phase to a more communicative situation; 2) build up metacommunicative awareness; and 3) develop metaphonological awareness so that the child can alter, or repair, output in order to convey meaning. The first prototype of Super-Fon implements Metaphon's phase 1 for now.

There are a few interesting related projects[9,10,11], but none of them follows the Metaphon methodology. For instance, the Phonological Processes app[12] was also created for children ages 4 and up, but it implements a linguistic approach by engaging users in minimal pair contrast therapy. The minimal pair approach to phonological remediation teaches children the function of sounds, emphasizing that changing sounds changes the meaning of a word[13]. Minimal contrast therapy targets pairs of words that differ only by one sound. Finally, it is worth noting that Articula[14] is an app for iPad which is the only solution found for the European Portuguese, aiming to support the training of correct articulation of consonantal phonemes. It includes game mechanics, but it does not present a story and its gameplay.

Besides summarizing the concept behind the Super-Fon approach, this paper is mainly focused on a user study conducted with children to find out if the first Super-Fon's prototype is well received by its potential end users. It was important to find out if it can provide a positive user experience towards its use as a real tool to engage children in therapy. Preliminary results show the promising prospects a mobile serious game solution holds in such contexts. Additionally, the study was used to select a group of children to integrate a Participatory Design (PD)[15] process for the rest of the development.

## 2. Super-Fon

The Super-Fon project aims to address the difficulties in self-management of the phonological disorders, including poor rates of adherence to therapy guidelines, in order to improve the awareness of children and their parents regarding the disorder they are facing. The main goal of the Super-Fon app is to increase children, their parents, and relatives, involvement in the therapy, engaging them to enhance control over the path of their disorder. This mHealth app should be used mainly in the scope of a speech therapy program with the supervision of a therapist, which is the user responsible for configuring the game according to each child's individual characteristics.

The prototype of Super-Fon was developed for Android Tablets and using the Portuguese language[6]. Summarizing its rationale and gameplay, the activities (real gaming moments) are organized according to the four levels of Metaphon's phase one: concept, sound, phoneme, and word. When a child responds to an activity, s/he will hear a positive or negative message along with a small animation according to her/his performance. In the case of success, the user will earn a digital coin, which can be used to buy stickers. Each sticker has a value, so the child has to earn as many coins as s/he can. A funny and engaging element in the game is the fact that the stickers can be printed in back and white in order to be colored by the child, who also collects them. These represent characters of the story that are also used to illustrate the activities (see Fig. 1). A "purchased" sticker fills a gap in the digital stickers' booklet, which was designed to stimulate the child to play the game and hit as many activities as possible, even after finishing a level. The gameplay requires a certain percentage of activities answered correctly in order to allow the user to go to the next level. More on Super-Fon can be found in [6].