Proposal of usability guidelines for the design of mobile applications in the rehabilitation of children with disabilities in working memory and verbal comprehension

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Abstract. Usability allows users to interact with a software application in an easier, more comfortable, and intuitive way, hence its importance for software design and development. However, there is an absence of clear rules on what and how to apply such usability in specific contexts. In this sense, this paper refers to the definition of a proposal to define and characterize usability guidelines that should be included when designing an interactive mobile application, specifically to help enhance rehabilitation processes in learning of children with cognitive disabilities between 6 and 8 years old, specifically in the ability of verbal comprehension and working memory. With this, it is expected to provide developers with a series of usability guidelines that can be useful for the design of this type of application, in such a way that they allow to improve the experience that children have when using them in the development of their skills, necessary for their rehabilitation. This paper aims to show the proposal framed in making a review, characterization, definition, and validation of these guidelines, the related works, and the methodology that will be carried out to obtain the proposed objectives.

Keywords: Usability guidelines, Interactive mobile application design, Cognitive disability, Rehabilitation.

1 Problem statement

The use of mobile devices is conditioned by the environment in which they are run, the type of users, and their software applications, consequently, it is necessary to take these conditions into account to offer suitable devices that satisfy the specific scenarios of the environment and its possible users [1]. One of the key elements that allow integrating these conditions is usability, as a relevant software quality characteristic, therefore, for its incorporation into software products, specific guidelines must be considered specific guidelines that allow compliance with the quality conditions of the product and also its context of use [2]. The quality of the software product is linked to the way in which it is developed, therefore it is necessary to provide usability guidelines, which allow providing relevant support in its construction in such a way that the applications meet the quality expectations and thus meet the needs of its users and the context [3].

On the other hand, there are multiple barriers (accessibility, assistive technology for motor or cognitive interaction, etc.) that disabled users face when they are at an infant age when using an application [4], evidencing the need for adaptable interfaces that allow their control through interoperable systems; further demonstrating that, despite the fact that these types of barriers affect a very broad group, cognitive accessibility studies are less developed than physical accessibility studies [5]. Considering that cognitive or intellectual disability is a problem characterized by delayed mental growth, this being an anomaly in the learning process, which refers to the late and incomplete acquisition of intellectual skills during human development [6]. Often, the learning disabilities in children can often be treated very successfully, which is why the goal of rehabilitation is to allow children to live with their limitations in the most productive way possible [7]. In this way, it can be said that a mobile application and specifically the design of its interfaces should be governed by guidelines that establish the best relationship between the child and the device, in such a way that these fulfill the function of supporting their rehabilitation [8] [9]. However, different technological tools have been perfected over time for support or rehabilitation, to which the patient, the therapist, or any personnel in the health area must adapt by adjusted instinct; That is why software construction must promote solutions that are usable, adaptable, and with understandable criteria linked to previously validated and current guidelines to the requirements that arise [10]. According to the different results in experimental tests in the professional therapist area [11], usability is a key practice in the specific development of tools for rehabilitation, in a greater focus when talking about patients at an infant age [12], This is due to the fact that the understanding of a software structure of adult users is totally different from a restricted audience such as children, in this way priority must be given and good interaction characteristics provided to the end-user, understanding the terms and characteristics of disabled children [13]. Likewise, there is a lack of research on usability elements for the development of mobile applications, specifically in the area of technological rehabilitation for people with cognitive learning disabilities [9] [14]. So, it is pertinent to ask: ***How to support the design of mobile application interfaces in the rehabilitation of verbal comprehension ability and working memory in children with cognitive disabilities in the age of 6 to 8 years?*** Since it is convenient to contribute to a better quality of experience that children have when using this type of application in their rehabilitation.

2 Justification

In the last decade, there has been an increase in people with diagnoses alluding to learning problems [15], wherein the design of applications that deal with their rehabilitation, generic usability elements have been used, defined for other technological processes and other contexts, making their adaptation forced and inadequate, compromising their essence [7]. On the other hand, the importance of verbal understanding is due to the fact that the human being is a social being in which the processes to transmit and assimilate experiences are imperative for their survival [16], for this, verbal communication plays a fundamental role, as one of the peculiarities that distinguishes people from

the rest of living nature [7]. Similarly, working memory is responsible for storing and temporarily managing all the information that is in use to carry out a specific task, in addition to regulating and using previously acquired information to perform complex cognitive tasks and develop intellectual abilities, such as reasoning and reading comprehension [16]. In addition, it is necessary to determine that the most suitable age for the use of technological tools for rehabilitation is between 6 to 8 years because, at this age, the user is in a condition to understand and adapt more easily to mobile environments, whether they are playful or learning [17], where the potential impact of technology is elevated by the ease with which they use technology from their first contacts [18]. However, usable software is mainly aimed at an adult audience, and when it is necessary to design mobile applications for children, most design guidelines and practices are used in the same way as for adults, these being inadequate, having taken into account that the context and the target audience require their own elements that help satisfy specific needs. Using proper design guidelines is vital for the software product to meet usability needs and meet development expectations [19]. Currently, there are some general guidelines that include usability elements, but there is little information available indicating how and when to apply them in specific contexts [20]. Therefore, defining guidelines appropriate to the context can help improve usability aspects in the general design of these applications [15].

3   Related works

Usability guidelines

In [21] usability guidelines are proposed for the design of interactive mobile applications for learning mathematics in children from 6 to 7 years old. Likewise, in [22] guidelines are presented for the development of interactive educational tools for psychomotor development in children from 3 to 5 years of age, which were validated through an experimental prototype. Similarly, in [23] the design guidelines for tangible mobile applications are proposed considering the cognitive capacity of the elderly. For his part in [24] The design of a guide for the development of applications focused on the teaching-learning process on cognitive flexibility is proposed for boys and girls diagnosed with grade 1 autism spectrum disorder. In [25] a study of the principles and requirements of user interface design using mobile devices as an instrument for mobile learning purposes is described.

Applications to support disabilities

In [26] a virtual reality application is defined that seeks that people with brain damage work to remedy or alleviate the cognitive deficits that arise after a neurological condition. In this same sense in [27] presents a web application to treat people with mild cognitive disorder present in most of the elderly, based on HTML5. In [28] a mobile application based on verbal imitation therapy is defined for children with autism between 4 and 8 years old, stimulating communication in verbal imitation therapy and in [29] educational software for the treatment of children with dyslexia is presented,

applying the MPIu+a for the design of User Interfaces, which work on a tablet to facilitate interactivity.

Some of the previous works have different perspectives related to usability guidelines used in different areas of health, showing necessary elements to consider according to their specific contexts, in addition to some tools focused on supporting different disabilities. However, none offers a set of guidelines that is specifically for the design of interactive mobile application interfaces in the rehabilitation of children with cognitive disabilities, which allows enhancing working memory and verbal comprehension, this being the greatest contribution of this work research.

4 Objectives

General objective
To specify usability guidelines for the design of interactive mobile application interfaces in the rehabilitation of children between 6 and 8 years old with cognitive disabilities, specifically enhancing the working memory and verbal comprehension.

Specific objectives

- To characterize, according to the literature, the existing usability guidelines that satisfy the design needs of this type of interfaces
- To build usability guidelines according to the context
- To validate the usefulness of the guidelines in the design of a software prototype to the context

5 Methodology

This work will be carried out following the bifurcation multi-cycle action research methodology[30] from which three cycles will be considered: conceptual, methodological, and evaluation. The cycles and their respective activities are briefly described below:

- ***Conceptual cycle:*** The planning and execution of the systematic mapping of the literature will be carried out to identify the characteristics of the end-users of the applications for the rehabilitation of children with cognitive disabilities in addition to characterizing the different sets of rules, guidelines, or existing components for the usable design of interactive mobile applications. Determining which of these guidelines are appropriate to the characteristics of the users in the context of the project.
- ***Methodological cycle:*** The structure and base format of the guidelines will be defined, where each of its components will be incorporated incrementally. They will be collected from the literature; they will adapt or define guidelines to incorporate them as part of the final proposal.
- ***Evaluation cycle:*** An evaluation mechanism will be chosen with which the usefulness of the proposed guidelines will be validated through the design of a software

prototype. The evaluation mechanism will be planned, designed, executed, and, considering the analysis of the results obtained, elements to improve will be established.

6   Conclusions

This paper presents the initial advance of the research that has allowed to establish a proposal that seeks to identify and characterize a set of usability guidelines that should be considered when designing an interactive mobile application, to help enhance rehabilitation processes in the learning of children with cognitive disabilities between 6 and 8 years old, specifically strengthening working memory and verbal comprehension. In addition, is identified with the review of the literature carried out so far, the importance of having the end-user of the applications, in this case, children, as a basis for the definition of guidelines to guarantee usability when developing software products for this context. According to the related works analyzed so far, there are different perspectives in the literature on usability guidelines, but none is focused on the design of interactive mobile application interfaces in the rehabilitation of children between 6 and 8 years old with cognitive disabilities. Therefore, this is intended to be the greatest contribution of this work, seeking that in the development of this type of applications it is possible to support the what and how to apply usability elements in this context and as a consequence, children have a better experience when using them.

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