Voiceguard: Using mHealth Technology for Vocal Health Promotion

Christina Cesar Praça Brasil[1], José Eurico de Vasconcelos Filho[2], Daniele de Araújo Oliveira Carlos[1], Thiago de Oliveira Magalhães[2] and Raimunda Magalhães da Silva[1]
[1]*Pós-Graduação em Saúde Coletiva, Universidade de Fortaleza, Fortaleza-CE, Brazil*
[2]*Laboratório de Inovação Tecnológica - NATI, Universidade de Fortaleza, Fortaleza-CE, Brazil*

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Abstract: This study aims to describe the development of an app for mobile devices to assist voice professionals in the management of vocal health. The research was held in two phases, from November 2014 to December 2015: 1) literature review and app stores search and 2) laboratory design, development and usability test. The multimedia feature was chosen for the app design and development, since it favours a motivating and dynamic environment. Teachers, when participating in the usability test, handled the tool for a few hours and issued their opinions. Data were analysed based on content analysis in the thematic mode. The results show the feasibility of the tool development to support and assist professionals in the care of their voice and open new perspectives to show that, in health promotion, technology can create new alternatives for health education and care, empowering the users.

1 INTRODUCTION

The use of m-Health technologies to promote vocal health is an issue that deserves attention in the current scenario, in view of the potential and vascularity of these technologies and the importance of voice for humans. The voice is a hallmark of the human being, is widely used in interpersonal, social and professional relationships. Characteristics such as sex, age, emotional state and personality are expressed through the vocal quality (Behlau et al., 2009). Moreover, the voice enriches the transmission of the word or message, both socially and professionally (Fabricio et al., 2010).

Among the professionals who use their voices as a working tool, there are the teachers, which intensively require this function and undergo several changes or even problems, due to lack of care and protective measures (Brazil, 2015). Vocal disorders in teachers represent a serious health problem, since it undermines the quality of life, work performance and compromises the quality of education (Fabricio et al., 2010).

Researches that investigated the vocal changes in teachers from different levels of education concluded that such prevalence is high, ranging from 21% to 80% (Roy et al., 2004; Strong et al., 2007, Brazil, 2015). Other studies that have captured information from teachers, showed a percentage of complaints related to voice that ranged from 54% to 79% (Gonçalves; Penteado; Silverio, 2005). These data reveal that there is a high incidence of voice problems among teachers, demonstrating that this profession can be demanding more attention from public policies to vocal health.

In this context, the technology brings new possibilities and resources that can make life easier for people and professionals to develop the health care, an example of this, are the mHealth technologies (Sarno et al., 2014).

In recent years, mobile health (mHealth), a branch of electronic health (eHealth), defined as "the use of computer technology and mobile communications in health care and public health" has been constantly expanding (Free et al., 2010). Thus, applications for mobile devices in health can cater to a heterogeneous audience (Free et al., 2010) and a wide variety of purposes (Riley et al., 2011).

The biggest advantages of using mobile applications in health consist in the fact that the devices are personal; that, nowadays, they have large processing capacity, several sensors (camera, microphone, accelerometer, gyroscope), internet connection; and are portable (Whittaker, 2012). Therefore, they can be used everywhere, even in everyday life and during hospitalization or rehabilitation. They can also meet the health care

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providers during routine visits or emergency procedures. In addition, the technology has been widely used by health professionals in health promotion strategies.

The high frequency of voice disorders in teachers and the lack of public policies for the vocal health of these professionals (Brazil, 2015), show that the creation of technologies that empower the teacher to take care of the voice can contribute to health promotion, improving quality of life and occupational conditions of this population.

Given the above, it was thought in a technological feature that allows the teachers and professionals who intensively use the voice, to monitor vocal health (even in real time), creating an interface between the users and the environment. This way, the aim of this study was to develop a technology for mobile devices as a tool for promoting the teacher's vocal health.

2 METODOLOGY

A study of exploratory and experimental type was conducted, from November 2014 to December 2015 in the Application Center for Information Technology of University of Fortaleza - UNIFOR in the state of Ceará - Brazil.

The project, is still in development with two concluded phases – 1) literature review and app stores search and 2) laboratory design, development and usability test.

In the first phase, after listening to the difficulties faced by the voice professionals (future users of the app) due to the needs to take care of their voices, it was carried out a literature review on the subject and context proposed, allowing the research team a better understanding of concepts, methodologies and tools of the involved areas. The review included a survey of the existing applications dedicated to vocal health. The team investigated the existing vocal health technologies through a survey conducted in the app stores on the web, on the Android (Google Play) and iOS platforms, using the following terms: vocal health, voice management and voice (in Portuguese and English). As a result, we identified, among others, four applications directed to vocal health, which approached the purpose of this study; besides VoxMetria tool, that is a specific software for voice analysis and voice quality.

The second phase, held in laboratory, contemplated the development of the application, with the participation of a multidisciplinary team of speech pathologists, computer engineers and graphic designers.

For the development of the tool, it was adopted a methodology in Human Computer Interaction area, the participatory interaction design (Preece et al., 2013), which was chosen because it focuses on the user´s needs and in its continued participation during the process. The interaction design is divided into four activities (Figure 1): identify user´s needs and establish requirements (for the system), conceive the solution design and (when necessary) the redesign, build an interactive version (working prototype) and evaluate the version produced with users.

Once established the requirements and based on them, the activity of design began. At this moment, drawings of system interfaces were built, in order to achieve the requirements, as well as usability and aesthetics. These drawings were understood by all the members of the staff, allowing reviews with the participation of potential users of the proposal.

Finalized the revisions (design and redesign) of the artefact, it was started the construction phase of the interactive version. In this phase, the programming/coding of technological artefact was made. For this activity, the team used the best practices and tools of the areas of Human-Computer Interaction and Software Engineering. The platform chosen for the application was Android, since it dominates more than 80% of the Brazilian market for mobile devices.

The last activity of the laboratory process corresponded to application usability evaluation (Barbosa and Silva, 2010). This evaluation aims to determine whether the application is understandable, easy to use and generates a good user experience. This assessment, however, does not evaluate the content or if the artifact produced, reaches the proposed objectives, leaving this evaluation to the next stage of the methodology. In this activity, 6 female teachers, from Yolanda Queiroz Elementary School participated. They received smartphones with the app installed a script of activities to be performed in the app, the activities were associated with the main system functions: register in the system, make a vocal analysis and check the result, set the "water time" function and get tips on vocal health. In addition to the script, a form (answered individually by each participant) so that impressions and opinions on the user experience could be registered.

As result of the usability evaluation, positive evidence was obtained, since the teachers considered the application easy to handle, they used it in the proper way and had a good user experience, despite some minor changes that have been suggested.

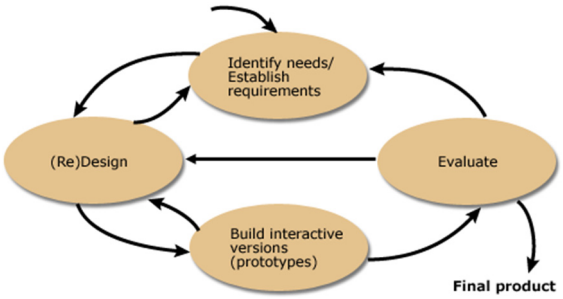


Figure 1: Interaction Design (Preece et al., 2013).

3 RESULTS

A first result of the project, from the literature review and the meetings with voice professionals (users) is the identification of the features/functions to be developed. A second result was the evaluation of the applications identified in the app stores based on the selected criteria. With this analysis, it was observed that the identified applications addressed the subject by focusing on specific points and did not offer features for managing, monitoring or a full self-care of vocal health, as can be seen in Table 1.

Based on the requirements and in the fact that there is no tool that would meet all these requirements, emerged VoiceGuard, a tool for mobile devices to the individualized support of the use of voice. The application is composed of 16 interfaces, each of them with a specific function. Table 2 shows the most relevant.

4 DISCUSSION

Throughout the research process, it was identified the lack of applications dedicated to vocal health. Thus, the VoiceGuard application brings new possibilities and helps professionals in the healthy use of this important tool that is the voice.

It is clear that technological advances have allowed the improvement of the media and bring to people the communicative interaction. Currently, the world has experienced the era of communication and health is one of the areas benefiting from the integration of these resources in the daily life of the population.

The VoiceGuard application fills a gap in the context of care to vocal health, giving users monitoring and self-management of vocal health through information, testing and alarm, setting an interface with the user. The application consists of a main menu covering six areas - voice analysis, sound level meter, time of water, results, tips and vocal heating - which unfolds in 16 interfaces, as outlined in Figure 1.

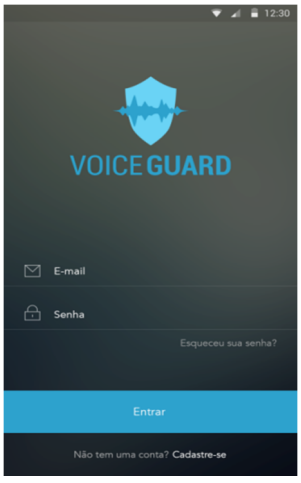
Each application area will be presented in detail in the following subsections:

Table 1: Evaluation summary of the applications studied based on the proposed requirements.

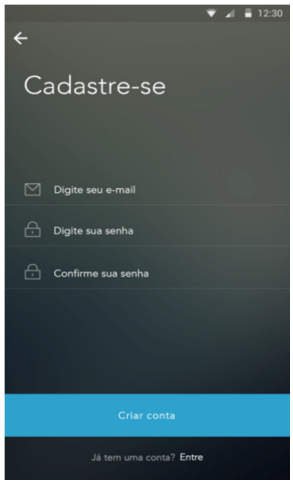
FEATURES / SYSTEMS	Vocal WarmUp	Saúde Vocal	Vocal Ease	Warm me up for singers	VoxMetria
Vocal warm-up	X	-	X	X	X
Ambient sound measurement	-	-	-	-	X
Vocal health analysis	-	-	-	-	X
Care history	-	-	-	-	X
Vocal health tips	X	-	-	-	X
Water intake reminder	-	-	-	-	-
Level of vocal protection	-	-	-	-	-

Legend: Symbol "X" mark the existence of the function in the application.

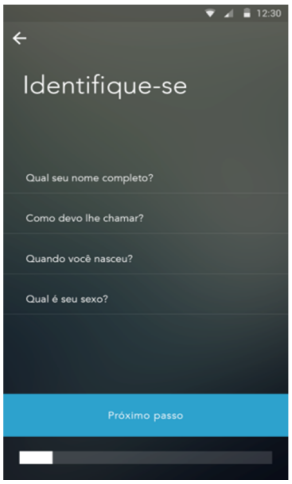
Table 2: Voice Guard interfaces.



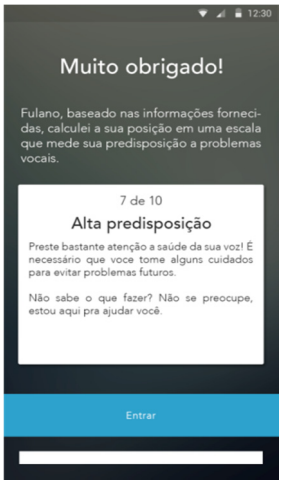
1. Login



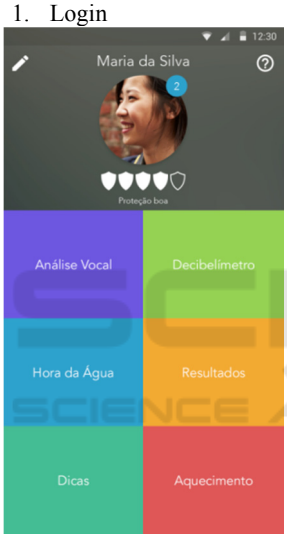
2. Register



3. User classification



4. Vocal risk classification



5. System menu

6. Test of Maximum time of phonation

7. Measurement of sound/noise

8. Water time function

4.1 Register and Access Functions

There are seven interfaces that correspond to the functions for: the presentation of the application, login in the application (Table 2-1), user registration (Table 2-2), user classification (Table 2-3), data sharing, predisposition classification to vocal risk (Table 2-4) and main menu (Table 2-5).

Other system functionalities and associated interfaces are explained below.

4.2 Vocal Analysis

The first interface to support Vocal Analysis, presents an explanatory text on the operation of functionality. This explanation has its origin from users questions, recorded during testing, and shows to user the operation that occurs on the interface that executes the test used to check the maximum phonation time - TMF (Table 2-6) and that presents the result of the test with explanation.

Regarding the voice analysis, we used the test to measure the Maximum Phonation Time (TMF). TMF is widely used to verify the voice quality, using, among others, the fricative phonemes / s / and / z / (Behlau et al., 2001).

The test is performed as follows: the user, by issuing the phoneme /s/ in a sustained manner after a single exhalation, have the time of issue timed by the application. After finalize the issue of the first phoneme, other phoneme (/z/) should be required.

The use of phonemes /s/ and /z/ establish the link that checks the condition of glottal closure. Thus, the test based on parameters validated by experts

(Miglioranzi; Cielo; Smith, 2012), provides data on the dynamics of vocalization, being quite reliable in the evaluation of glottal efficiency. It is noteworthy that the normal range of s / z ratio is estimated at approximately 1 second (Gelfer; Pazera, 2006).

If the result of this test is less than 0.8, it indicates excessive coaptation of the vocal folds, which harms the vocal health of teachers, because it is perceived excessive effort to speak. Results from 0.8 to 1.2 is indicative of normality, suggesting that there is a normal operation of the vocal folds. Finally, the result of more than 1.2, indicates soprosity, i.e., there is an air leak between the vocal folds during phonation (Christmann et al., 2012).

The presented feature enables check and provide an overview of the glottal operation of each user, helping them in self-monitoring of vocal glottal efficiency. These results may alert about the signs of possible changes in the glottal closure, serving as a warning to seek expert help. The application also allows sharing the results in real time, with the speech therapist and/or physician, who are accompanying the teacher.

Another function is that, after the indication of the result of this test, the application presents the individual explanations of the identified condition, the interface results. With this, the user can access the tips interface where he/she will learn about the preservation of vocal health. It is clear that technology can influence and change the way of living and acting of people, even when these issues go through the care and health promotion context. Thus, it confirms the importance of incorporating advanced technologies in scenarios of assistance to vocal health as it implies a redefinition of self-care (Silva; Ferreira, 2009)

4.3 Decibelimeter

Another important function of VoiceGuard is the decibelimeter, which captures and shows the level of environmental noise. Moreover, it is possible to identify the noise spikes that exceed the acceptable intensity for the preservation of vocal health. For this purpose, the application presents three interfaces: explanations of the functions on the Main Menu, noise/sound measurement (Table 2-6) and the results of the noise measurement.

Studies show that noise is considered one of the most important risk factors for voice disorders in teachers. When the teacher is in the classroom and under the influence of noise, trying to be heard, he/she normally exceeds the voice intensity. Without realizing it, the teacher becomes vulnerable to the appearance of vocal disorders (Baring & Murgel, 2005; Brazil, 2015).

A study of Guidini et al. (2012) shows that, according to NBR 10,152, the acceptable noise level in the classroom must remain 40dB to 50dB (A). Thus, the application presents the following parameters to alert the user to the level of environmental noise: audible alarm - generates acoustic signals when the noise exceeds 50dB, conditioning students to reduce the parallel conversation or remain silent during the class; and visual alarm - reinforces the idea of the loud noise through the issuance of lights and aids in listeners behavior conditioning.

4.4 Water Time

The "water time" is another application function that helps professionals to condition themselves to drink water during vocal use. For this, the interfaces of "water time" (e.g. Table 2-8) are available.

The device enables the user to program the times for water intake over the work shifts. The application signals through visual and audible alarms the time for water intake, reminding the professional this as an important action for continued hydration and maintenance of vocal health. It is also possible that the user reports how many glasses of water he/she drank during the working day (Table 2-8).

Hydration is recommended in both the prevention and treatment of voice disorders. It is known that the benefits of hydration are many, such as: reducing the viscosity of mucus in the larynx and facilitating mucus-wave motion. Thus, a more hydrated mucosa provides greater flexibility to the vibration of the vocal folds, increasing vocal resistance and reducing the sensations related to vocal effort (Medaglia et al., 2008).

4.5 History Log

The interface of “History Log” provides access to the application user history and gives access to tips of voice heating and cool-down.

The interface that corresponds to the "results" is simple. It is possible to see the results of all tests, and enable visualization of comparative graphs. It also allows data sharing with the health professional who takes care of the app user. The VoiceGuard keeps in chronological sequence the results of the tests performed by the users and of other tests they want to register (reports or images).

Finally, the "heating and cool-down" is a tool that is still in the test phase for improvement. In this

interface, the user can perform simple exercises of voice heating and cool-down, before and after voice use, respectively.

5 CONCLUSION

The VoiceGuard application was designed in order to facilitate the improvement of the management of vocal health, aiming the adoption of habits and behaviors able to maintain healthy voice, which is consistent with the health promotion strategies.

As the mobile technology is present in everyday society, use it as a resource in health care can be a quick, easy and inexpensive strategy to achieve a considerable number of people. Therefore, we believe that the mobile application as a tool for vocal health promotion is a necessary resource and a new possibility for professional voice in the current context.

The usability testing gives us a positive and preliminary indication of acceptance and positive impact of the tool. All invited users were able to meet the proposed activities in an average time considered good, without doubts about the interaction with the tool and with some good suggestions (embraced by the staff) to change some terminologies and the location of information in the interfaces.

A third phase will be conducted after the development of the VoiceGuard, in which it will be validated with experts in voice and a larger number of elementary school teachers, in order to be available for free in the app stores.

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