Stop Anxiety: Tackling Anxiety in the Academic Campus Through an mHealth Multidisciplinary User-Centred Approach

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Abstract. Anxiety-related disorders have a strong impact on our quality of life. With their epidemiological prevalence, across the population, highly exceeding the capacity for treatment in health facilities, new ways of delivering therapies are needed. The wide availability of mobile technologies, e.g., smartphones, has provided an accessible and ubiquitous platform for delivering psychological therapies and many mobile health (mHealth) systems have been proposed to support users in managing their levels of anxiety. However, many of the available tools provide features without evidence-based support of their adequateness and effectiveness. Furthermore, several tools are designed without specifically considering the users' needs and motivations, resulting in poor adherence or a lack of motivation for systematic use, hindering any positive effects.

Considering the need to more closely focus on the motivations of the target users, this article describes how the efforts of a multidisciplinary team are contributing to support a user-centred approach to design and develop a tool to support anxiety management in the context of an Academic Campus. As a first materialization of this ongoing work, a proof-of-concept application is proposed (StopAnxiety), developed by adopting an iterative approach, and already providing a set of clinician-approved anxiety management techniques.

Keywords: Anxiety · mHealth · Mental health

1 Introduction

The prevalence of mental health disorders across the population has been rising at an alarming rate, having an impact not only in people's lives, but striking a

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major hit in worldwide economy. One of the main reasons of this economy burden is the fact that mental health disorders are not an isolated problem, being in many cases, the cause of diseases in other medical areas, such as cardiology [11].

Considering the spectrum of mental health illnesses, anxiety is one of the most common, having a stronger impact on disability and impairment than many chronic medical disorders [12,16,24]. Apart from those that are diagnosed with pathological cases of anxiety, healthy individuals also feel the impact of anxiety on their daily activities, their relationships, and their general mood [5,11,14]. Even though several mental health therapies have already been developed to deal with this issue, many individuals suffering from anxiety disorders do not have access to them, in health facilities, either because they cannot afford it or because of the effects that are inherent to their condition, such as the lack of emotional self-awareness (not allowing them to express what they are feeling since they cannot figure it out by themselves) or the fear of social contexts [12,16]. Nevertheless, even disregarding these considerations, with the growing epidemiological prevalence of anxiety-related disorders, it would not be possible for the health services to provide face-to-face therapy to those in need. Thus, the proposal of methods that could help individuals manage and reduce their own anxiety, in a more independent manner, is of the utmost relevance.

Mobile technologies have provided a promising platform to support people in a wide variety of contexts and mobile Health (mHealth) tools have been proposed to help people in various scenarios, improving their awareness about their condition, providing continuous support, and fostering independent living. In this regard, mHealth approaches for anxiety management have also been proposed. However, while there is a wide range of such tools, most of them are proposed without involving users in their design, providing therapies that lack scientific grounds and evidence of efficacy, and failing to engage users for a long-term use.

To propose novel approaches and methods to tackle these issues, we adopt a multidisciplinary user-centered approach to the design and development of a novel anxiety management system—StopAnxiety—,by working with psychology professionals and potential users and by putting a strong effort in understanding user motivations and in providing evidence-based practises. Without loss of generality, and considering the prominence that anxiety has in the academic context, we consider students and teachers as the targeted audience.

The remainder of this document is organized as follows: Sect. 2 provides a brief overview of current work regarding the proposal of support systems to tackle anxiety; Sect. 3 describes the work carried out to identify the needs and motivations of several users dealing with anxiety, in an Academic Campus; Sect. 4 provides an overview of the accomplished iterative design and development of StopAnxiety, a proof-of-concept mHealth application for anxiety management; finally, Sect. 5 presents overall conclusions and provides several ideas for future work.

2 Mobile Applications for Anxiety Management

With a wide spectrum of available technologies with potential to support anxiety management [9], smartphones have been the main choice due to their high ownership rates (+2 billion owners worldwide), and to the fact that they consist in a portable, ubiquitous and fairly accessible platform [2].

Regarding mental health, several applications have been proposed to provide different levels of support, such as exposure exercises, progressively exposing users to their inner fears, psycho-educational, where the users learn about the existing disorders and how to deal with them, at an early stage, or those suggesting psychological intervention techniques, through which users can manage and reduce their own anxiety levels by performing exercises.

To gather an overall view of the most recent and best considered mobile apps for tackling anxiety, based on community feedback, a review of anxiety management applications was conducted. From the reviewed apps, it was possible to verify that most of them were developed targeting any age, apart from FearFigther [8], WhatsMyM3 [10], Happify and WoeBot [9] that specifically targeted adult individuals. Most of the reviewed apps considered cognitive behavioural therapy principles [1,3,7], one of the most common and best studied forms of psychotherapy, as the base of their proposed interventions. Related to how important the usability factor is, in order to engage the user until the conclusion of the treatment, many features were considered by the reviewed apps, such as in WoeBot [9], where a chatbot is used for the interaction and treatment delivery process, and ThisWayUp, where a comic book style approach is explored. Two positive aspects that were observed, were that all of the reviewed apps, except for AnxietyCoach, were validated in studies regarding their effectiveness, and that all of them proposed therapies that were supported on scientific evidence. However, one of the main problems is that, even though all the apps that were assessed involved a domain expert, in their design and development phase, most of them disregard both the involvement of the patient, and the possibility of communication with the health provider through the application. Additionally, while the reviewed applications are well recognized by the community, adherence continues to be an issue. And the panorama beyond these top applications rapidly gets worse, in a number of aspects, even for those that are commercially available.

Overall, the general conclusion is that even though mHealth applications have an incredible potential for granting additional access to mental health care, there is a significant gap between their commercial availability and the data regarding their efficacy and effectiveness. In this regard, several challenges can be identified:

– **Inappropriate treatments and Lack of Evidence**—One of the most common problems amongst the majority of the commercially available applications for tackling anxiety is the wrong suggestion of treatments, being most of them inappropriate and not even scientifically proven. This is a serious problem that needs to be dealt with since it could actually worsen the health status of the users rather than bring them the health benefits they need [23];

- **Lack of adherence/User engagement**—User engagement is another aspect that should as well be accounted for, since most users that look for these types of applications tend to download them and only use them for a few hours before uninstalling them. This can happen either because they feel that the application does not provide them with the satisfaction of use they desire or the health benefits they need. This way, many users do not use applications long enough to feel the benefits [17];
- **Lack of user involvement in establishing the requirements**—The disregard of the patients in the requirement elicitation phase is something that is very common to happen in the development of anxiety management systems (and mHealth applications, overall), generally due to how important time constrains and commercialization aspects are for the development companies. Unfortunately, this is not an isolated problem since it also has a negative impact in other aspects, such as user engagement and the appropriate proposal of treatments [18].
- **Application efficacy is not clear, and lack of long-term assessment**—Despite the evolution and widespread use of these mHealth apps, there is still a lack of data regarding their efficacy and effectiveness. Many are even released to the market categorized as medical aids, but lack any evidence of their impact [21].

3 Users, Context, and Requirements

The first stage of our work consisted on the identification and characterization of the potential users. To this end, a multidisciplinary team was formed, including psychologists, software, human-computer interaction, and mobile computing engineers, university teachers, and university students.

3.1 Personas

Personas depict fictional characters with the purpose of representing different user types that might use the application, and although they do not actually represent real people, they are based on real data collected from different individuals. These representation profiles can help the developing team to step out of themselves and recognize that different people may have different needs and expectations, allowing the team to focus their attention in what really needs to be designed and further developed, enabling users to properly achieve their own goals [6]. One additional advantage of using Personas, in this process, is that their narrative form helps on multidisciplinary dialogue, improving the outcomes of the discussions [22].

In a first stage, to characterize the users that could benefit from an anxiety management aid, in the academic campus scenario, the team resorted to a brainstorming session, grounded on the anxiety literature, and on the experience of the team elements, regarding anxiety issues in the academic context. The data collected in this session led to the identification of different target groups and

Table 1. Persona of Rute, an undergraduate student.


Image adapted from pxhere.

Rute is 20 years old and is currently completing the second year of her degree in Nursing, at the University of Aveiro. She spends much of her time studying for her exams, which is something that always made her very anxious. Although Rute spends a large part of her day trying to study, she often faces blockages that prevent her from progressing, eventually becoming even more anxious than she already is. Despite the adaptation struggles that Rute was faced with, in her first year of college, she still considers that the evaluation periods are the hardest. During her studies, and moments before the start of her exams, Rute normally begins to sweat from her hands, to tremble, and she feels an heavy chest. Sometimes, during the course of her exams, these symptoms are accompanied by blanks, which consequently prevent her from applying the knowledge she knows she has.

Motivation: Rute would like to get the grades that she so hardly worked for by learning how to deal with her anxiety attacks during the course of her exams.

initial versions of Personas were proposed. To further extend these first versions of the Personas, and to validate the initial team considerations, three focus groups were carried out: one with academy students, another with professors, and another with psychologists working with students suffering from anxiety. These discussions enabled a more accurate identification of user motivations and of the main aspects that triggered anxiety issues.

With all the data that was gathered, from both the focus groups and the team brainstorming sessions, five Personas were deemed relevant for a proper characterization of the context of the anxiety management tool to be developed: (a) three primary Personas for different college student profiles (first year students, students in evaluation periods, and students suffering from social anxiety); (b) one primary Persona for a university professor; and (c) one served Persona for a clinical psychologist. From those, and given their extent, only two are provided here, in more detail, for illustrative purposes: the Persona of Rute, an undergraduate student, mostly suffering from anxiety during evaluation periods (Table 1); and Carlos, the Persona of a college teacher (Table 2). Rute is an undergraduate student who is unable to obtain the desired academic performance due to the extreme anxiety she goes through during her evaluation periods. As such, she would like to learn about some possible techniques that would help her remain calm, especially, during times of greater stress. Carlos is a teacher whose main source of anxiety is his inability to manage its own schedule in an efficient way. As such, he would like to have a way to access relaxation techniques so he could relieve the stress of his daily life, and manage his schedule.

Table 2. Persona of Carlos, a University Professor.

Image adapted from pxhere.

Carlos is a 47 year old college teacher who has taught at the University of Aveiro for 10 years. During his free time he enjoys doing activities, such as spending time with his children, traveling, going to the gym, reading the newspaper, and socializing with his family and friends. Typically, at the end of each day, due to the stress that comes from his work, he arrives home very tired. Carlos feels that he is overwhelmed by an immense amount of work, which occupies most of his time, and he feels his work is not valued enough.
Motivation: Carlos would like to learn about some techniques and procedures that could help him deal with his daily anxiety and stress, particularly in a way that could be available during is daily routines.

3.2 Context Scenarios

Context scenarios can be seen as a way to describe how the envisaged support system can be used to achieve a specific goal, in a certain context, and how it integrates the user's activities and for how long [6]. With this in mind, to perceive the different ways in which the anxiety management tool could be used, several context scenarios were developed. The scenarios were built based on the literature for the different ways to deal with anxiety (e.g., respiratory exercises), covering the contexts reported, by the users, during the focus groups and validated by clinicians to guarantee their validity and appropriateness. Although several context scenarios have been proposed to properly guide the development of the application, given their extent, and for the sake of brevity, only one of them is provided. This scenario represents a situation in which the application detects an increase of Rute's anxiety and proposes the execution of a diaphragmatic breathing exercise.

Rute performs diaphragmatic breathing a few moments before an exam—*The last exam of this semester will start in 15 min. Given the accumulation of tiredness, anxiety and study content that is required for this frequency, the application acknowledges that Rute is very anxious and consequently proposes the execution of a diaphragmatic breathing exercise, a technique that is frequently performed by Rute before any of her frequencies. Before the technique's initiation, the system asks Ruth to sit comfortably, and prepares her for a series of inspiration and expiration cycles. In order to facilitate the realization of this technique, the system emits vibratory signals, given that she is in a crowded and noisy place, so that Rute can feel and understand the transition of each breathing cycle. At the end of each breath, Rute feels more and more relaxed and confident to complete the exam. After the end of this frequency, the student verified that she did not have any brain fade during its course, and that she was capable of answering to all its questions.*

It is important to note that the vibratory alerts were selected instead of the audible ones due to the fact that Rute is in a public space. Also of note are the underlined parts of the scenario, highlighting relevant actions that the system will have to provide, i.e., the requirements.

3.3 Requirements

As a result of all the information gathered about the users, their motivations, and how the system should perform to help them, documented in the scenarios, a first list of requirements was established and is presented in Table 3. For each requirement, a priority level was defined, thus, providing the developers with a grasp on how to select them for the iterative development stages, as explained, ahead, in this document.

It is worth noting that, even after several development iterations, the evaluations that were carried out did not motivate changing any of these initially proposed requirements, but only the way in which they were being accomplished, which further confirmed the validity of the captured user necessities.

Table 3. Requirements subset

Prio.	Subset of elicited requirements
1	1. Implement relaxation techniques
	2. Identify users emotional states
	3. Create safe and highly available users data models
2	4. Allow time scheduling
	5. Present users progress statistics
	6. Adapt application to the user's context
	7. Learn about user preferences
3	8. Allow users to register their thoughts (wav, txt,...)
	9. Provide psychoeducation notifications throughout app usage
	10. Provide psychoeducation section for learning purposes
	11. Enable communication between patients and clinicians
	12. Enable communication among peers

4 Design and Development of StopAnxiety

An iterative User-Centered Design approach was considered for the development of the proposed anxiety management system. Considering the initial subset of requirements, several iterations were performed, and each of the developed prototypes was evaluated by users, resulting in a prototype deemed adequate to undergo first evaluations in more ecological settings. In what follows, we provide a summary of the various iterations carried out, to illustrate how the process evolved, and pay a more detailed attention to the current StopAnxiety version.

4.1 Low-Fidelity Prototype

Paper prototyping is a widely used method in user-centered design approaches, helping developers to prototype systems that meet their user's expectations and needs. Its great advantage is that it allows making quick and cheap changes to the prototype rather than to the system already developed. In light of these considerations, the initial step was to build a paper mockup of the interface layouts that would enable fulfilling the requirements. A few examples are depicted in Fig. 1.

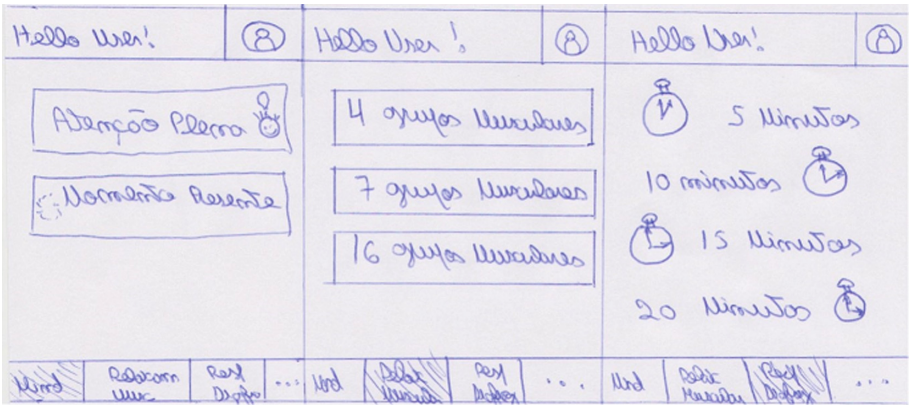

Fig. 1. Paper prototype example

The paper mockup was discussed in a brainstorming session including all elements of the multidisciplinary team, with overall good feedback about the devised approach. One of the suggested modifications concerned how the user's progress in the different activities would be presented. It was suggested that successful completion of exercises would result in advancing their score, but they would not be penalized for those they were not able (or did not want) to complete. So, at most, their stats would remain the same. By doing so, their motivation would not be negatively influenced and their progress would be continuous, although at a slower rate in case of unsuccessful usage.

4.2 First Functional Prototype

The first functional prototype implemented a refined version of the approved paper mockup, leaving out the full implementation of the exercises. The main goal was to have a first iteration of the overall interaction approach for a first usability evaluation. Figure 2 presents some illustrative screen layouts for this initial version.

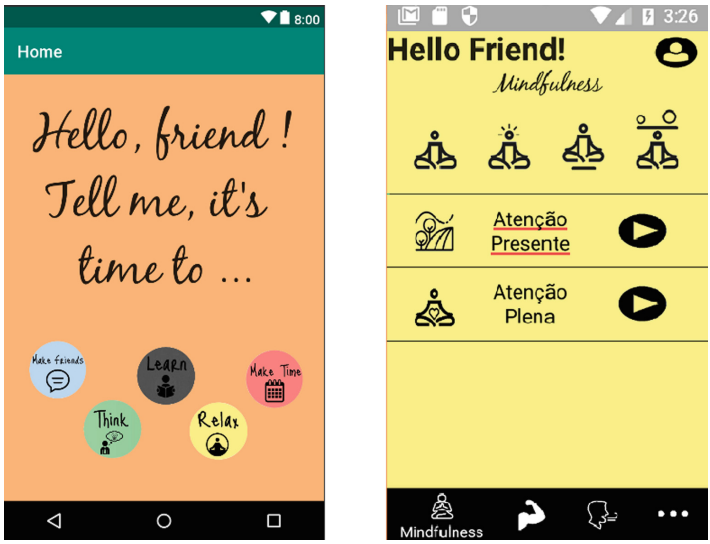

Fig. 2. First illustrative layouts

Regarding the early stage of development, the first prototype was then subjected to an heuristic evaluation, considering Nielsen's heuristics [19], so that potential usability problems could be detected and inform further developments. Five evaluators, three males and two females, aged between 22–24 years old, computer science students, with previous experience in applying heuristic evaluations, analyzed the prototype assessing each violation of the heuristics with a score from 0 (no usability problem) to 4 (major problem preventing the use of the application). Additionally, the evaluators were also asked to suggest possible solutions to solve the detected issues.

Taking into account the identified usability problems, that resulted from this evaluation, the most concerning ones were related to the lack of provided feedback, in cases where input fields were incorrectly filled in or when the user's personal information was updated. The need for additional guiding information was also identified, to allow users to understand some of the system's features. Additionally, it was verified that some core features for dealing with errors and customizing use were missing, such as the possibility of undoing information changes, selecting the alarm type of the techniques, and logging out of the application. In terms of facilitating aspects, it was also deemed useful to have shortcut buttons allowing users to skip guiding information that they already knew.

4.3 Second Functional Prototype

Among the changes considered for the second prototype, the most prominent included the implementation of notifications, with the intent of providing the user with appropriate feedback in each of its action executions, and of new

features that were missing, such as logging out of the application or accessing additional information regarding the several existing techniques. Depicted in Fig. 3 are examples that illustrate some of the implemented changes.

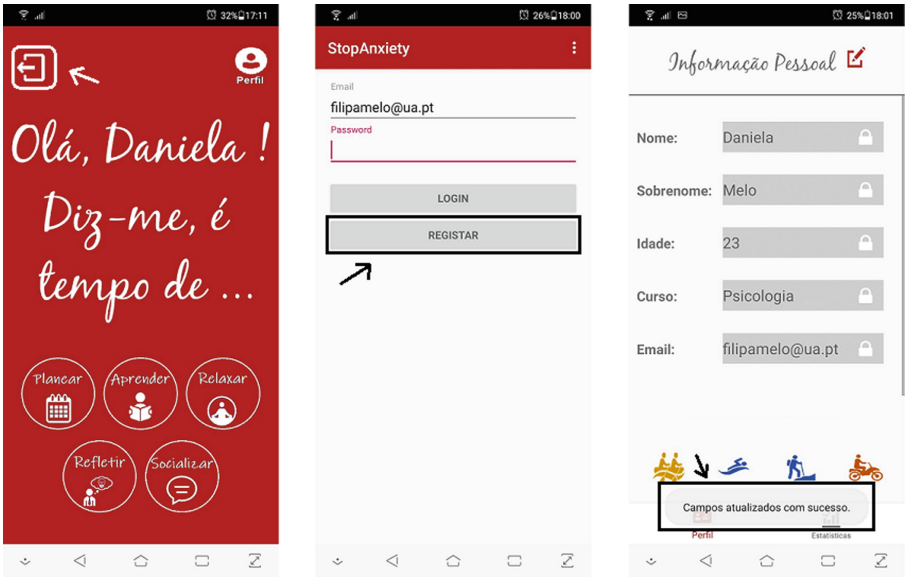

Fig. 3. Implemented changes example

For the second functional prototype, since it already provided a considerable amount of features, the main intent for the evaluation was to discover usability problems made evident while using the application to reach concrete goals. As such, a Think Aloud protocol was applied, asking users to perform specific tasks by using the application, while giving feedback of what they thought and the difficulties they were faced with. For this evaluation, five participants were considered, different from those performing the heuristic evaluation, four males and one female, aged 22–25, all computer engineering students with experience in mobile applications development.

During this session, the participants were asked to perform 10 tasks (see Table 4) and the following variables were measured: the success/unsuccess of the tasks, the time to completion, in seconds, and the number of errors and unforeseen events during their execution. In addition to the proposed tasks, at the end of the evaluation, each participant answered a SUS [4,15] and a PSSUQ [13,20] questionnaire. While there is an overlap between some of the outcomes provided by both questionnaires, we considered that applying both would provide a richer set of information.

Regarding the obtained results, although all the participants were capable of successfully completing the 10 tasks, some difficulties were still encountered.

Table 4. Tasks performed by users during the usability evaluations.

Tasks
1. Register in the application
2. Log in to the app
3. Edit and complete your profile
4. Get more information about the Muscle Relaxation Technique
5. Setup the Diaphragmatic Breathing Technique for a duration of 7 min
6. Select the mute option in the Diaphragmatic Breathing Technique menu
7. Perform the Technique for approximately 1 min
8. Return to the menu of the Diaphragmatic Breathing Technique and perform it with sound
9. Perform the Muscle Relaxation Technique by contracting and relaxing one of the indicated muscle groups
10. Log out of the application

Despite that, the performed SUS and PSSUQ assessments revealed average scores of 75 and 2.176 respectively, which classifies the application as already having a good level of usability, however, still with space for improvements.

4.4 Current Version of Stop Anxiety

Considering the outcomes of the last evaluation, the development of a third version of the prototype ensued. This time, the focus was to further improve usability, and provide a complete implementation of the provided techniques, not only to further validate the application, but also to enable a first assessment of their impact in dealing with anxiety. In what follows, we provide an overall summary of the currently supported set of features.

4.4.1 Main Features

After signing in, the user can access the various features that are present in StopAnxiety from the home screen, where a message is displayed saying "Hi, Daniela! Tell me, it's time to...", followed by the options: "Relax", "Plan", "Learn", "Think", and "Socialize". Note that this way of presenting the user with the different options derives from the fact that we wanted to put the user at the center of the action. It is what he wants that matters, instead of just providing options, such as "Relaxation Exercises", "Schedule Planning", and "Psychoeducation".

Depicted in Fig. 4 are the initial steps that are required for the user to perform in order to successfully access the application.

Regarding the system's main features, when the user chooses to "Relax", several techniques are available for him to perform, such as Mindfulness, Diaphragmatic Breathing, and Progressive Muscular Relaxation. After selecting one of

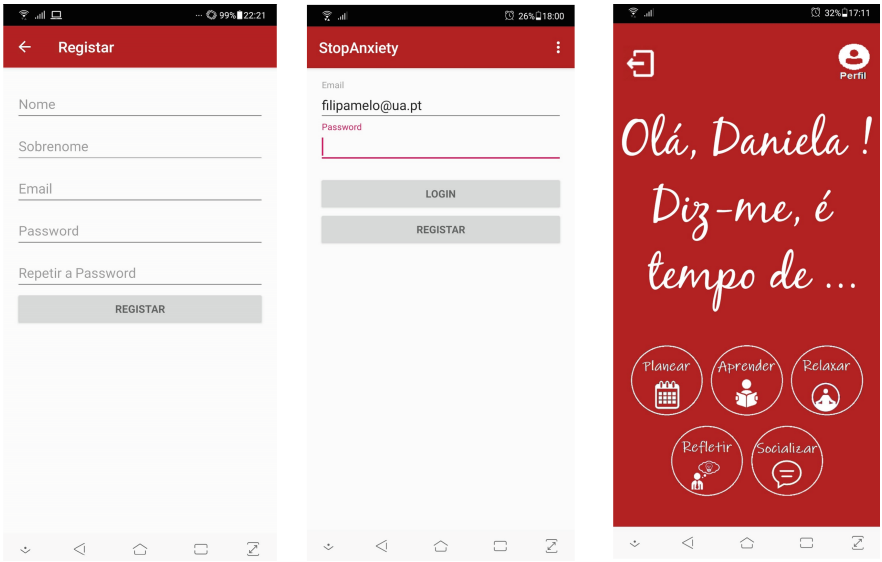

Fig. 4. Required steps for the initial login and the home screen from where the main features can be accessed.

the available techniques, the system provides him with the corresponding technique's procedure, where the user can inform himself before starting its execution. Throughout the technique's progress, the system keeps the user updated with information regarding the steps to perform to successfully complete it. For example, by selecting one of the Progressive Muscle Relaxation Techniques, the system immediately displays its corresponding procedure, using a slideshow, and subsequently provides him with instructions of when and which muscle group needs to be contracted or relaxed. While the muscles and the instructions are presented in the screen, a voice guide is also available for cases when the user simply wants to enjoy its experience without having to look to the screen (Fig. 5).

4.4.2 Evaluation

In order to verify the system's usability improvement after the implementation of the changes that were deemed necessary, for the current version, both the same tasks and evaluation instruments were selected. For this evaluation, five new participants were considered, three females and two males, aged between 21–26 years old, all computer science engineering students. This time, the participants did not have any problems in accomplishing the tasks that were proposed which, since that was not the case in the previous evaluation, might be indicative of an improvement in the usability levels of the application.

In fact, average values of 90.5 and 1.608 were obtained for the SUS and PSSUQ scales, respectively, which demonstrates a notorious improvement compared to the values of 75 and 2.176 from the previous usability evaluation. It

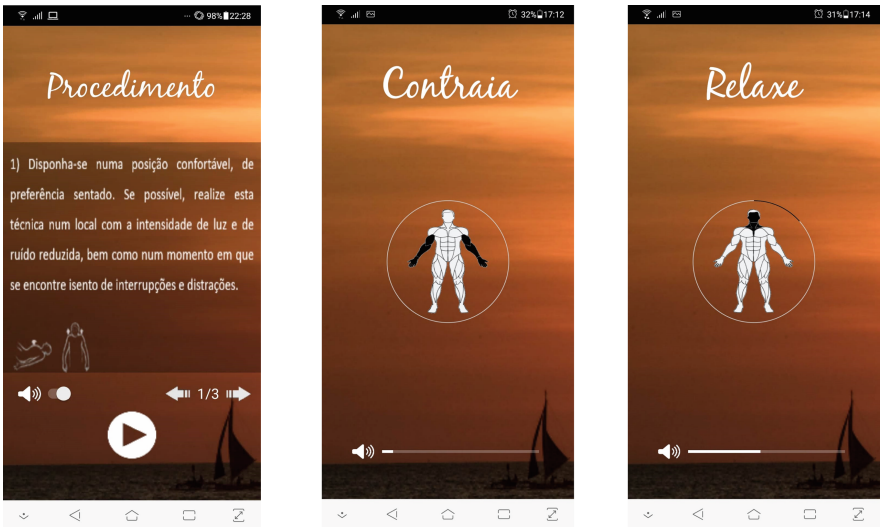

Fig. 5. Progressive Muscle Relaxation Technique. From left to right: the instructions screen, the instruction to contract the muscles in the arms, and instruction to relax the head and neck muscles.

should be noted that the obtained results categorize the assessed application as having a quite satisfactory level of usability, allowing its users to have a highly intuitive and pleasant navigation process.

With the achievement of these results, the current version is deemed ready for an evaluation regarding the impact that the available techniques have in the users anxiety levels.

5 Conclusions and Future Work

This article presents first results of a multidisciplinary user-centered effort to propose support tools for anxiety management. To this end, there was a need to consider methodologies that allowed a more efficient and effective multidisciplinary teamwork and a complete specification of user's needs, motivations and scenarios of use. As such, tools like Personas and Context Scenarios were used, to both foster an easier communication between the team members, and enable an appropriate elicitation of the requirements that served as the foundation to the correct development of the anxiety management system.

Considering the particular case of anxiety management in the academic campus, a proof-of-concept application was developed, adopting an iterative User-Centered Design and development approach, which ensured that the resulting system met the goals and needs of the target users. The resulting application incorporates several evidence-based techniques, such as, Mindfulness, Diaphragmatic Breathing and Progressive Muscular Relaxation. Nevertheless, at this

time, we are designing an experimental protocol to assess the actual impact of the anxiety management techniques provided by StopAnxiety in tackling anxiety.

Regarding further evolution of StopAnxiety, a few notable aspects should deserve prompt attention. It would be important to provide a time management feature that suggests schedules adapted to the tasks and biological rhythms of the users, since this is an issue that was transversely identified, during the focus groups, as being one of the main promoters of anxiety in both students and teachers. It would also be highly beneficial to evolve the psychoeducation section, allowing users to learn about the main symptoms of the existing conditions and teaching them how to deal with them, at an early stage, possibly preventing them from developing into real disorders. And, naturally, the user emotional state and context (e.g., time of day, task, location) can be a valuable set of information to adapt the application's response to the user, enabling, for instance, a prompt action when an anxious state is imminent (e.g. suggesting an anxiety management technique adequate for a public place). In this regard, work is ongoing regarding the integration of the emotional state and context of the user.

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