Universidade de Aveiro
2019

Departamento de Eletrónica,
Telecomunicações e Informática

David da Cruz Ferreira

StopAnxiety: Gerir a Ansiedade no Lugar

StopAnxiety: Tackling Anxiety in Place

Universidade de Aveiro
2019

Departamento de Eletrónica,
Telecomunicações e Informática

David da Cruz Ferreira

StopAnxiety: Gerir a Ansiedade no Lugar

StopAnxiety: Tackling Anxiety in Place

Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia Informática, realizada sob a orientação científica do Doutor Samuel de Sousa Silva, Investigador do Instituto de Engenharia Eletrónica e Telemática de Aveiro, e sob a coorientação do Doutor Ilídio Fernando de Castro Oliveira, Professor Auxiliar do Departamento de Eletrónica, Telecomunicações e Informática da Universidade de Aveiro, e da Doutora Sandra Cristina de Oliveira Soares, Professora Auxiliar do Departamento de Educação e Psicologia da Universidade de Aveiro.

o júri / the jury

presidente / president	Prof. Doutora Maria Beatriz Alves de Sousa Santos Professora Associada com agregação do Departamento de Eletrónica, Telecomunicações e Informática, Universidade de Aveiro
vogais / examiners committee	Prof. Doutor Telmo Eduardo Miranda Castelão da Silva Professor Auxiliar do Departamento de Comunicação e Arte, Universidade de Aveiro
	Doutor Samuel de Sousa Silva Investigador do Instituto de Engenharia Eletrónica e Telemática de Aveiro (orientador)

agradecimentos /
acknowledgements

Gostaria, em primeiro lugar, de agradecer ao meu orientador e aos meus coorientadores por toda a ajuda por si disponibilizada durante o realizar desta dissertação.
Um especial obrigado ao Prof. Doutor Samuel Silva, que durante todo este processo de desenvolvimento não só me orientou, como também se tornou um amigo com o qual poderia contar para qualquer eventualidade.
Um agradecimento à Prof. Doutora Sandra Soares, do Departamento de Educação e Psicologia, pelos conhecimentos transmitidos na área da Psicologia e pelo contributo dado nos artigos científicos realizados.
Gostaria também de agradecer ao grupo de trabalho, com o qual tive o prazer de trabalhar de forma multidisciplinar durante o realizar desta dissertação, por todo o apoio e espírito de equipa por eles facultado.
Ao Nuno Almeida, um obrigado por toda a ajuda providenciada relativamente ao uso apropriado do módulo da framework multimodal, o que permitiu o aprimoramento adequado da Modalidade Afetiva inicialmente proposta, e, ainda, pela ajuda na escrita do artigo científico respetivo à mesma.
Ao Prof. Doutor António Teixeira, um agradecimento por todas as sugestões, por si facultadas, para a melhoria do artigo científico da Modalidade Afetiva.
Um grande obrigado ao Prof. Doutor Ilídio Oliveira pela ajuda na definição da arquitetura da versão estendida da Modalidade Afetiva, permitindo, assim, o seu apropriado desenvolvimento.
A todos os participantes das avaliações efetuadas e dos focus groups realizados, um grande obrigado, pelo tempo disposto e pelo afinco com o qual realizaram todas as tarefas que foram solicitadas.
Finalmente, mas não menos importante, gostaria de agradecer a todas as pessoas que me foram e são importantes na minha vida. Os meus sinceros agradecimentos por toda a confiança que depositaram em mim e por toda a ajuda que me disponibilizaram durante esta árdua etapa do meu percurso académico-profissional.

Palavras Chave

Saúde móvel, desenvolvimento centrado no utilizador, computação afetiva, interação multimodal, modalidade afetiva, sistemas com consciência emocional, StopAnxiety.

Resumo

As perturbações de ansiedade apresentam um forte impacto na nossa qualidade de vida. Considerando a sua prevalência na população, que excede a capacidade de tratamento em unidades de saúde, tornam-se necessários novos métodos de administrar psicoterapias. Neste sentido, atendendo à ampla disponibilidade de tecnologias móveis, que consistem em plataformas altamente acessíveis e omnipresentes, novas formas de administrar psicoterapias têm sido disponibilizadas, fomentando, deste modo, a proposta e desenvolvimento de sistemas de saúde móvel (mHealth) com o propósito de auxiliar os utilizadores na gestão e redução dos seus níveis de ansiedade. No entanto, apesar de existirem inúmeras aplicações móveis de suporte à saúde, muitas destas não apresentam evidências científicas da adequação e eficácia das técnicas por si disponibilizadas e são geralmente desenvolvidas sem considerar as necessidades e motivações dos seus utilizadores, resultando, na maioria dos casos, numa reduzida adesão, na ausência de motivação para a sua utilização contínua, e, ainda, na possibilidade de exacerbar a sintomatologia ansiosa experienciada pelos utilizadores. Considerando o que foi referido, e tendo em conta a importância de atender às necessidades e motivações do público-alvo, esta dissertação descreve os primeiros esforços, integrados numa abordagem multidisciplinar centrada no utilizador, para o desenvolvimento de um sistema de gestão de ansiedade em contexto académico. Assim sendo, como primeira materialização deste projeto, uma prova de conceito é apresentada (StopAnxiety), a qual foi desenvolvida recorrendo a uma abordagem iterativa de desenvolvimento, e que suporta um conjunto de técnicas de gestão de ansiedade já validadas por clínicos. Complementarmente à prova de conceito realizada, e considerando as vantagens em contextos de interação, e para o contexto da ansiedade em particular, de conhecer os estados emocionais dos utilizadores, é igualmente apresentada uma iteração melhorada de uma modalidade afetiva genérica, resultante da extensão de um estudo anteriormente elaborado, que deverá permitir, no futuro, explorar a consideração dos estados emocionais dos utilizadores para adaptar o funcionamento do sistema de suporte, e.g., propondo técnicas de gestão de ansiedade quando o estado emocional o justifique.

Keywords

Mobile health, user-centered design, affective computing, multimodal interaction, affective modality, emotionally-aware systems, StopAnxiety.

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 deemed necessary. As such, and with the wide availability of mobile technologies, which consist of a highly accessible and ubiquitous platform, new ways for delivering psychological therapies were made available, fostering, this way, the proposal and development of mobile health (mHealth) systems to support users in managing their anxiety levels. However, although several mobile applications for health support already exist, many of them provide features without evidence-based support of their adequateness and effectiveness and are designed without specifically considering the users' needs and motivations, resulting, in most cases, in poor adherence, lack of motivation for systematic use, and, additionally, in the possibility of exacerbating the users' anxious symptomatology. In light of these considerations, and with the need to more closely focus on the needs and motivations of the target users, this dissertation describes the first efforts, integrated in a multidisciplinary user-centered approach, for the development of a system for anxiety management in the academic context. As such, and as the first materialization of this ongoing work, a proof-of-concept application is proposed (StopAnxiety), which was developed by adopting an iterative approach and that already provides a set of clinician-approved anxiety management techniques. In addition to the presented proof-of-concept application, and considering the advantages in interaction contexts, and for the anxiety context in particular, of knowing the users' emotional states, an improved iteration of a generic affective modality is also presented, resulting from the extension of a previously elaborated work, which should allow, in the future, to explore the consideration of the users' emotional states to adapt the functioning of the support system, e.g., by proposing anxiety management techniques when the emotional state justifies it.

Contents

Contents i

List of Figures v

List of Tables vii

Glossary ix

1 Introduction 1

1.1 Context and Motivation . . . 1
1.2 Challenges . . . 2
1.3 Objectives . . . 3
1.4 Contributions . . . 4
1.5 Overview . . . 4

2 State of the Art 7

2.1 Smartphones as a way to deliver Mental Health Treatments: Potential benefits and registered flaws . . . 7
2.1.1 Anxiety-related mental Mobile Health (mHealth) apps: categorization and inherent benefits . . . 8
2.1.2 Systematic reviews of anxiety apps: major pointed concerns . . . 11
2.2 A roadmap to mHealth approaches in tackling anxiety . . . 13
2.3 Development of Multimodal Interactive Systems . . . 14
2.4 Discussion and Conclusions . . . 16

3 Personas, Context Scenarios, and Requirements 17

3.1 Identifying users and their motivations . . . 18
3.2 Context Scenarios . . . 22
3.3 Requirements . . . 24
3.4 Discussion and Conclusions . . . 25

4 Application Development **27**

4.1 System Architecture . . . 27

4.2 First Iteration: Paper Mockup Development . . . 28

4.2.1 Paper Prototype . . . 28

4.2.2 Paper Mockup Validation . . . 29

4.3 Second Iteration: Paper Mockup Transposition Into a Preliminary Application Version 30

4.3.1 Prototype Development . . . 30

4.3.2 Heuristic Evaluation . . . 31

4.4 Third Iteration: Second Prototype Development Considering the Last Assessment's Issues . . . 32

4.4.1 Prototype Development . . . 32

4.4.2 Usability Evaluation . . . 36

4.5 Fourth Iteration: Development of the Current Application Version . . . 38

4.5.1 Prototype Development . . . 39

4.5.2 Usability Evaluation . . . 43

4.6 Application Current State . . . 44

4.7 Discussion and Conclusions . . . 47

5 Affective Modality **49**

5.1 Generic Affective Modality Conceptualization . . . 49

5.1.1 Conceptual Vision on Affective Computing in a Diverse Multimodal Interactive Ecosystem . . . 50

5.1.2 Modality's Requirements . . . 51

5.2 Generic Affective Modality's Development . . . 52

5.2.1 Modality's Architecture and Implementation . . . 52

5.2.2 Implementation . . . 53

5.2.3 Integration in the applications' context . . . 53

5.3 Modality's Integration in the Proposed Anxiety Management System . . . 54

5.4 Discussion and Conclusions . . . 56

6 Conclusions **59**

6.1 Overall Analysis . . . 59

6.2 Future Work . . . 60

References **63**

Appendix A . . . 67

Appendix B . . . 78

Appendix C . . . 80

Appendix D . . . 83

Appendix E 85
Appendix F 88

List of Figures

2.1 Proposed intersection of multiple complementary research areas. 14
2.2 Multimodal Interactive Architecture. 15

4.1 Paper Prototype example. 29
4.2 Users' statistics screen 30
4.3 First illustrative layouts. 31
4.4 Application's feedback. 33
4.5 Additional technique's information. 33
4.6 Technique progression bar. 34
4.7 Additional icon descriptions. 34
4.8 Additional functionalities. 35
4.9 Last user's email. 35
4.10 Technique's guide. 36
4.11 SUS and PSSUQ scores, by participant (Third Iteration). 38
4.12 User's profile information. 40
4.13 Techniques' textual descriptions. 40
4.14 Guide's slideshow. 41
4.15 Countdown timer. 41
4.16 Logout confirmation. 42
4.17 SUS and PSSUQ scores, by participant (Fourth Iteration). 44
4.18 Required steps for the initial login. 45
4.19 Mindfulness technique variants' nature videos. 46
4.20 Progressive Muscle Relaxation technique. 46
4.21 Relax section technique's sub-menus. 47

5.1 Overview of the deployment of emotionally-aware applications in diverse scenarios. 50
5.2 Affective Modality's architecture and supporting modules. 52
5.3 Practical example of the Modality's Integration. 55
5.4 Technique's suggestion after a sadness emotion update is received. 56

5.5 Technique's conclusion survey. 56

List of Tables

2.1 Apps review results. 10

3.1 Persona of Rute, an Undergraduate Student. 20
3.2 Persona of Mafalda, an Undergraduate Student. 20
3.3 Persona of Henrique, an Undergraduate Student. 21
3.4 Persona of Carlos, a University Professor. 21
3.5 Persona of Margarida, a Clinical and Health Psychologist. 22
3.6 Set of requirements. 25

4.1 Observational results table (Third Iteration). 37
4.2 Observational results table (Fourth Iteration). 44

Glossary

mHealth	Mobile Health
ESA	Emotional Self-Awareness
MHL	Mental Health Literacy
CBT	Cognitive Behavioral Therapy
CSE	Coping Self-Efficacy
RCT	Randomized Controlled Trial
UCD	User Centred Design
HCI	Human-Computer Interaction
SUS	System Usability Scale
PSSUQ	Post-Study System Usability Questionnaire
ECG	Electrocardiogram

CHAPTER 1

Introduction

With the epidemiological prevalence of anxiety-related disorders across the population that highly exceeds the capacity of treatment in physical establishments, new ways to tackle them are deemed necessary. As a response to such a problem, technology emerged as a way to cover a wider audience in the treatment of these types of disorders, being smartphones the main focus due to how ubiquitous and accessible they are. Although the impact of the existing disorders is transversal across a broad range of contexts and audiences, one in which there is a clear impact is the academic setting, where both teachers and students are subject to high levels of anxiety. As such, and considering the current ubiquity of smartphones, and the high prevalence of anxiety disorders across the population, the proposal of mobile health (mHealth) approaches might provide individuals with alternative practices to help them manage and reduce their levels of anxiety for a diverse range of audiences and contexts in which anxiety problems are predominant.

1.1 Context and Motivation

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 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 [1]. Considering the spectrum of mental health illnesses, anxiety takes place as one of the most common, having a greater impact on disability and impairment than many chronic medical disorders [2–4]. But apart from those that are diagnosed with anxiety, more and more healthy individuals begin to realize how negative emotions and lack of anxiety management can impact their performance in their daily activities, their relationships and their general mood [1, 5, 6]. Even though several mental health therapies have already been developed to deal with these issues, many of the individuals that suffer from anxiety problems do not have access to these treatments in clinical establishments, either because they cannot afford it or because of the effects that are inherent to their conditions, 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 [3, 4]. But even disregarding these considerations, with the actual, and still growing, epidemiological prevalence of anxiety-related disorders across the population, it would not be possible for health services to provide face-to-face therapy to all these individuals, since their numbers vastly exceed its capacity. Thus, there is a need for the development of effective digital technologies to help individuals manage and reduce their levels of anxiety.

Associated with the fast pace of technology evolution, several technologies have continuously been made available, fostering new forms of treatment for anxiety-related disorders. With a wide spectrum of available technologies with potential for the anxiety treatment, as noted in [7], smartphones are the main focus due to their ownership rates being extremely high, over 2 billion owners worldwide, and to the fact that they consist in a portable, ubiquitous and fairly accessible platform [8].

1.2 Challenges

Even though the number of currently available anxiety-related mHealth apps is immense, little is known about some of their core aspects, such as the quality of their content, proposed treatments, empirical support and treatment efficacy. With the purpose of assessing the commercially available anxiety mHealth apps, some systematic reviews have been recently conducted, and the general conclusion is that even though they 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. With this said, there are still some aspects that critically need to be dealt, and challenges that need to be tackled to shorten this existing gap and ensure their appropriate development, namely:

- **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 can actually worsen the health status of the users rather than bring them the health benefits they need [9];
- **Lack of adherence / User engagement**

  User engagement is another aspect that should also 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 features they desire or the health benefits they need. This way, many users do not use the applications for long enough to feel the potential benefits [10];
- **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 constraints 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 [11].

- **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 [12].

- **Privacy and security**

  Although how vast their numbers might be, many mHealth applications are still not equipped with measures to protect their users' personal medical information, and considering how private and sensitive that data is, it is crucial that its security and privacy is assured [13]. However, this is typically due to the fact that many of these applications are available without any costs, being their ways of profit, the sale and sharing of their users' medical data.

- **The affective context is seldom considered**

  While mHealth applications have the potential to address several problems and provide numerous benefits, such as covering a wider range of contexts and audiences, and offering an alternative to treatment in physical establishments, it would still be additionally advantageous if they could be aware of their users' emotional states. Provided with such knowledge, they could adapt themselves, and their proposed techniques, to provide their users with unique and personalized experiences, e.g., suggesting techniques that have worked well in previous occasions [14]. One of the main barriers for considering the affective context is often due to the complexity of integrating it without having to master a set of complex technologies.

1.3 Objectives

Considering the identified challenges, our overall objective is to propose a system to aid its users in managing their anxiety levels, and, additionally, contribute to setting a roadmap for the appropriate development of mHealth approaches for tackling anxiety. To accomplish this overall goal, we aim to:

- Identify the main aspects that need to be tackled to improve the impact of mHealth approaches in anxiety management;
- Evolve previous work regarding how emotional context can be brought into applications, in the context of mHealth development, enabling an easier approach to its integration, by developers, and the proposed systems to adapt to human affects that are successfully recognized and interpreted;
- Adopt a multidisciplinary user-centered approach to the design and development of an anxiety management system, by collaborating with care providers and potential users, establishing first grounds to pursue the proposed roadmap;

- Propose a proof-of-concept application, adopting an iterative design and development approach, showcasing the overall aspects of the devised approach.

1.4 Contributions

Part of the work developed and described in this dissertation has already been accepted for presentation in an international conference:

- David Ferreira, Daniela Melo, Andreia Santo, Pedro Silva, Sandra C. Soares, Samuel Silva, "Stop Anxiety: Tackling Anxiety in the Academic Campus through an mHealth Multidisciplinary User-Centred Approach", Proc. MobiHealth 2019 – 8th EAI International Conference on Wireless Mobile Communication and Healthcare, Dublin, Ireland, [accepted], November 2019;
- David Ferreira, Nuno Almeida, Susana Brás, Sandra C. Soares, António Teixeira, Samuel Silva, "Enabling Multimodal Emotionally-Aware Ecosystems through a W3C-aligned Generic Interaction Modality", Proc. MobiHealth 2019 – 8th EAI International Conference on Wireless Mobile Communication and Healthcare, Dublin, Ireland, [accepted], November 2019;

While the first one presents initial results of a multidisciplinary user-centered effort to propose support tools for anxiety management, the second one proposes a conceptual vision for the deployment of multimodal emotionally-aware ecosystems, showcasing an improved version of a key component in this vision, a generic affective modality.

Additionally, a brief overview of the multidisciplinary effort adopted to characterize the potential users and contexts has been submitted to an international conference:

- David Ferreira, Daniela Melo, Pedro Silva, Andreia Santo, Nuno Madeira, Sandra C. Soares, Samuel Silva, "Supporting Anxiety Management through mHealth: Methods and First Contributions Considering the Academic Campus", submitted to the 28th European Congress of Psychiatry, 2020

1.5 Overview

The remainder of this dissertation consists of 5 chapters, organized as follows:

- Chapter 2, State of the Art: This chapter focuses on discussing the related work, and on giving a general overview of what has been the main directions and pointed out concerns in mHealth development for tackling anxiety. A small introduction is made about this work's theme, and to why, given the epidemiological prevalence of anxiety-related disorders, it is crucial that technologies are considered for covering a wider audience in these disorders' treatment. As the chapter's conclusion, a roadmap for the appropriate development of mHealth approaches for tackling anxiety is presented, along with an introduction of the development of multimodal interactive systems and why its consideration can be important for the work to be carried out.

- Chapter 3, Personas, Context Scenarios, and Requirements: This chapter describes the requirements elicitation phase, responsible for identifying the requirements that served as the foundation for the appropriate development of the anxiety management system. This methodology follows a User Centred Design (UCD) approach which is considered to be quite effective in developing systems that meet its users' expectations, since it mostly focuses on their needs rather than the personal assumptions of the developers. All the performed focus group, interviews, and brainstorming sessions are described, and so are the used methodologies, and resulting considerations, that led to the proposal of the first set of requirements.
- Chapter 4, Application Development: In this chapter, the entire iterative process, related to the development of the proposed anxiety management system is described, always considering the needs and referred suggestions that resulted from the elaborated evaluation sessions. As the chapter's conclusion, the current application's state is presented and its implemented features are described.
- Chapter 5, Affective Modality: In this chapter, a brief introduction to Affective Computing is made, and it is further highlighted how important it is in the development of systems that are capable of capturing, processing, and interpreting human affects. Following this, a conceptual model for integrating affection in diverse interactive contexts is presented, evolving previous work. Lastly, the architecture and development of an Affective Modality are detailed, along with the presentation of a practical example of its integration in the proposed anxiety management system.
- Chapter 6, Conclusions: The last chapter begins with an overview of the developed work, and suggests some future considerations and possible improvements in order to further evolve it.

CHAPTER 2

State of the Art

Given the emphasis that has been rightly placed on the prevalence of mental disorders across the population, new ways of delivering psychotherapies have been extensively explored, not only to reach wider audiences but also to address the inability of physical establishments to provide face-to-face treatments to all the anxiety-suffering individuals. The already high, and still growing, proliferation rate of smartphones grants the availability of an accessible and ubiquitous platform for delivering psychological therapies. With this in consideration, many mHealth apps have been continuously developed so that individuals can be provided with digital technologies to help them manage and reduce their own levels of anxiety. But even though mental mHealth apps are highly available in the market, recent studies have shown that there is a need for the establishment of norms and guidelines for their development due to important aspects that they lack. In this context, this chapter identifies the main aspects that are amiss among the state of the art of the mental mHealth apps for dealing with anxiety and highlights some considerations to support the work to be carried out.

2.1 Smartphones as a way to deliver Mental Health Treatments: Potential benefits and registered flaws

This section serves as an overview of the state of the art in mHealth apps for anxiety contexts in order to express and point out their potential benefits and registered flaws.

To gather knowledge of the area, a revision method was followed, which consisted of both the study of articles, and the review of some of the already existing apps for anxiety management. However, and due to the fast pace of technology evolution and its consequent obsolescence, the considered timespan for the analyzed articles ranged between the years of 2015 and 2018. Specifically, the revision method consisted of the study of articles regarding mental mHealth, articles regarding general mobile apps' usability, and the review of the 20 mental mHealth apps for tackling anxiety that are considered the best by the PsyberGuide's domain experts, an app rating platform focused on the mHealth app marketplace [11, 15].

2.1.1 Anxiety-related mental mHealth apps: categorization and inherent benefits

Due to the current epidemiology of anxiety disorders across the population and the consequent need for the development of technologies for increasing the access to its treatments, the number of available mental mHealth apps have been constantly growing. However, although how vast their number might be, they can still be classified as one of these three broad types: focused on reflection; focused on education; and focused on goals.

Mental mHealth apps that are focused on reflection, such as the one proposed in [16], are designed to improve emotional self-awareness through the consideration of self-monitoring features. By increasing the patient's Emotional Self-Awareness (ESA), a greater capacity to regulate what they are feeling is being granted, so that they can adapt their behaviour to specific contexts and not overreact whenever stressful situations might occur.

Regarding educational focused mental mHealth apps, their main objective is to increase the user's Mental Health Literacy (MHL). It consists in supplying them with information about mental health disorders since such knowledge aids them at their recognition, management, and prevention.

At last, but not least, mental mHealth apps that are focused on goals are designed to improve Coping Self-Efficacy (CSE), which is a type of self-efficacy that grants individuals a higher level of trust in themselves and in their capacity to deal with stress and adversities. Two examples of applications that consider the suggestion of activities, in order to improve the user's CSE, could be the ones proposed in [17], which consists in the proposition of exposure exercises in daily life, and [18], where smartphone usage patterns are analyzed in order to predict negative emotions and therefore suggest relevant emotion regulation activities that consider the current user's context.

However, and independently of the treatment delivery types, the inclusion of the clinician should always be considered since it plays a key role in the patient's treatment process, not only ensuring a higher probability of the therapy's conclusion but to adapt the treatment to how the patient is performing. Additionally, and considering the impact that the contexts in which the users are at can have in their anxiety levels, it would be highly advantageous for the clinicians if they could be made aware of them, allowing them to adapt their therapies to better aid their patients in facing such circumstances. Given that anxiety-generating situations can occur in diverse ways and scenarios, smartphones emerge as a good solution for this problem due to their mobility aspect, which makes them a tool capable of providing in-place anxiety management techniques. Besides, the connectivity and multiplicity of its sensors create immense potential for detecting the contexts in which the users are present, something that is central to allow the adaptation of the proposed techniques for managing and reducing their anxiety levels.

The consideration of the users' emotional states is not only important for the adaptability of interactive systems but for allowing a correct user diagnosis and consequent proposition of appropriate therapies as well [19, 20]. Regarding the ways of identifying users' emotions, two main approaches are considered: subjective (through self reporting) and objective (through

the usage of sensors and external hardware).

In the present context, subjective methods are considered to be less intrusive and easier to establish, due to the fact that attaching extra hardware may not be feasible regarding the mobility aspect, as noted in [21], and to the possibility of avoiding expensive computations. However, besides being more complex to implement, many approaches to objectively identify emotions have already been developed and validated in how highly accurate they are at doing so. Two examples of such approaches could be the ones proposed in [21], where the user's emotional state is predicted according to his finger strokes during his app interaction process, and [22], where mobility data is passively collected by the integrated mobile sensors and is further analyzed to predict changes in the user's emotional state.

In light of these mentioned considerations and concerns, for the apps review process conducted in this study, the variables deemed relevant for consideration were the following: (1) targeted diagnostic/symptoms; (2) targeted population's age (children, adult, elderly, any); (3) intervention type (Cognitive Behavioral Therapy (CBT), Psychoeducation, Self-Monitoring); (4) app characteristics (video, graphs, questionnaires, games, etc); (5) considered treatments; (6) integrated communication with the health providers; (7) involvement of licensed and domain experts in the app design and development process; (8) consideration and involvement of the users in the app design and development process; (9) app efficacy evaluation; (10) proposal of scientifically proven techniques; (11) developers type (individual, organizational, academic); (12) app category (Medical, Health & Fitness, Educational); and (13) platform (iOS, Android).

Application	Sympt. /Diag.			Age	Intervention			Features	CPCI			Val.	Theory-based	Devel.		Plat.	
	D	A	S	*	C	P	S	*	C	P	U	*	*	A	O	A	i
EmoRecorder + PAR[18]	•	•	•	ANY	•			Questionnaires, Texts, Graphics, Images, Maps.	X	✓	X	✓	✓	•		•	
Challenger[17]		•		ANY	•			Gamification, Texts, Graphics, Images, Maps, Games, Challenges.	✓	✓	X	✓	✓	•			•
MoodPrism[16, 23]	•	•		ANY	•			Texts, Questionnaires, Graphics.	X	✓	X	✓	✓	•		•	•
MHFirst Aid	•	•		ANY		•		Texts, Questionnaires, Images.	✓	✓	X	✓	✓		•		•
HeadSpace[24]		•	•	ANY	•			Animations, Texts, Images, Videos, Questionnaires, Graphics.	X	✓	X	✓	✓		•	•	•
BrainHQ		•	•	ANY	•			Graphics, Images, Animations, Questionnaires, Videos, Games, Puzzles.	X	✓	X	✓	✓		•	•	•
FearFigther[25]		•	•	ADULTS	•			Graphics, Images, Animations, Questionnaires, Videos, Games.	✓	✓	X	✓	✓		•	•	•
WhatsMyM3[26]		•	•	ADULTS			•	Graphics, Questionnaires.	✓	✓	✓	✓	✓		•	•	•
ThisWayUp[27]		•	•	ANY	•			Animations, Questionnaires, Comic book style.	✓	✓	X	✓	✓		•	•	•
cogniFIT[28, 29]	•	•		ANY	•			Animations, Questionnaires, Graphics, Games.	x	✓	X	✓	✓		•	•	•
MoodMission[27, 30]		•	•	ANY	•			Images, Questionnaires, Graphics, Challenges.	X	✓	X	✓	✓		•	•	•
Personal Zen[31]		•	•	ANY	•			Images, Questionnaires, Graphics, Games.	X	✓	X	✓	✓		•		•
Happify		•	•	ADULTS	•		•	Images, Questionnaires, Graphics, Games.	X	✓	X	✓	✓		•	•	•
MoveMe		•	•	ANY	•	•		Images, Videos, Scheduling, Challenges.	X	✓	X	✓	✓		•	•	
PurpleChill		•	•	ANY	•	•		Images, Audio.	X	✓	X	✓	✓		•	•	
Day to Day		•	•	ANY	•	•	•	Images, Texts, Lessons.	X	✓	X	✓	✓		•	•	•
Worry Knot		•	•	ANY	•	•	•	Images, Texts, Lessons, Graphics.	X	✓	X	✓	✓		•	•	•
WoeBot[32]		•	•	ADULTS	•		•	Chatbot, Questionnaires, Videos, Images.	X	✓	X	✓	✓		•	•	•
AnxietyCoach		•	•	ANY	•	•	•	Graphics, Questionnaires, Texts, Challenges.	X	✓	X	X	✓		•		•
MoodKit[33]		•	•	ANY	•		•	Graphics, Questionnaires, Texts, Challenges, Mood Diary.	X	✓	X	✓	✓		•		•

Symptoms and Diagnosis: (D)epression; (A)nxiety; (S)tress.
Intervention Type: (C)ognitive Behavioural Principles; (P)sychoeducation; (S)elf-Monitoring.
Clinician-Patient Communication and Involvement : (C)linician communication; (D)omain Expert Involvement; (U)ser Involvement.
Developers Type: (A)cademic/Individual; (O)rganizational.
Platform: (A)ndroid; (i)OS.

Table 2.1: Apps review results.

2.1.2 Systematic reviews of anxiety apps: major pointed concerns

Even though the number of currently available anxiety-related mHealth apps is immense, little is known about some of their core aspects, such as the quality of their content, proposed treatments, empirical support and treatment efficacy. To assess the commercially available anxiety mHealth apps some systematic reviews have been recently conducted, and the general conclusion is that even though they 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 the study conducted in [7], several technologies for the delivery of anxiety treatments were considered for assessment, from first-generation approaches, which consist of computerized therapies, to newer methods of treatment delivery, such as smartphone apps and virtual reality interventions. As noted in the study, one of the major considerations of clinicians and researchers should consist in finding innovative ways to keep the patient engaged until its treatment's completion, due to the low rates of therapy conclusion, especially, if an unguided therapy method is considered [10]. Another relevant consideration that was pointed-out was the necessity of collaboration between healthcare, research, and commercial sectors to successfully translate the scientific discoveries into technologies that support everyone in their everyday lives.

In another systematic review of anxiety apps, conducted in [11], a great emphasis was placed on the need for designing and developing platforms that could help patients and health care providers in selecting which anxiety-related apps would better suit their needs. Due to their great abundance, the process of choosing the best turned into a challenge. While user ratings exist and are normally considered by consumers in the app selection process, they not always reflect how good apps are for mental health, being usually assessed by their interactivity and general usability rather than their validation or proposed techniques. In light of this challenge, the development of app review platforms was suggested, granting access to expert reviewed and validated mental health apps for anxiety management without having to worry about the negative impact that a badly chosen app could have. However, as indicated in [9], there is a consequent problem from the diversity of these app evaluation tools, since a lack of consensus between them results in a completely incoherent set of app proposals.

Another important aspect in which anxiety-related apps seem to lack is their general usability. As mentioned in [12], while there is, currently, a huge private investment in the development of commercial mHealth apps to increase and improve chronic disease management, and decrease the treatment's costs, these gains will not materialize unless their usability is significantly improved. As such, and to possibly avoid this problem, it is deemed relevant that usability tests for mHealth apps precede their corresponding efficacy and efficiency tests.

Although all the systematic reviews that were mentioned thus far pointed-out valid and worrying concerns that need to be addressed, the systematic review of anxiety apps conducted in [37] identified very concerning aspects in the current field of anxiety apps that need an urgent consideration for their consequent improvement. The study itself consisted in the assessment of the 52 best commercial applications, according to the app marketplaces rankings, that were

mainly focused in general anxiety. The authors downloaded and tested each application and further verified the existence, or absence, of variables that they deemed relevant for their apps assessment and evaluation process. After the analysis of the retrieved data, it was verified that from the 52 originally considered applications, only 63.5% of them indicated what type of principles were considered for their proposed techniques, with many of them considering some that were not even scientifically proven. 67.3% of them did not mention the involvement of any domain expert or medical licensed individual in the app development process, which obviously impacts its credibility. And the most concerning aspect was that only 3.8% of the considered apps showed any information regarding its efficacy, which is something that should be considered as critical for the users' app selection process.

It is of the utmost importance that the proposed treatments are scientifically proven to bring health benefits to the users, otherwise, it could even do the opposite by hampering their health status. Another consideration to have is the privacy and security of the users' data, not only because of how sensitive and private medical data is, but because, nowadays, a lot of apps that are currently available for free profit by sharing or selling their data [34].

In an attempt to verify the current state of the actual, and best considered, commercially available mobile apps for tackling anxiety, an app review process was conducted in this study, being a summarized version of the results depicted in Table 2.1. The selection process of the applications to be reviewed in this study was carried out in accordance with the ratings available on the PsyberGuide platform [15], which currently consists of the most active and comprehensive app rating platform in the United States that focuses on the mHealth app marketplace [11].

As a first step through the results, it is possible to verify that most of the apps were developed regarding any age, apart from FearFigther [25], WhatsMyM3 [26], Happify, and WoeBot [32] that specifically targeted adult individuals. Overall, most of the reviewed apps proposed techniques based on cognitive behavioral therapy principles [35–37], which consists of one of the most common and best-studied forms of psychotherapy. Related to how important the usability factor is to engage the user until its treatment's conclusion, many features were considered by the reviewed apps, including novel approaches, such as in WoeBot [32] where a chatbot is used for the interaction and treatment delivery process, and ThisWayUp [27] where a comic book style approach is explored. Two positive verifications that were made was the fact that all of the reviewed apps were validated in studies regarding their effectiveness, apart from AnxietyCoach, and proposed therapies that are scientifically proven. However, one of the main problems that was found was that even though all the assessed apps involved a domain expert in its design and development phase, most of them disregarded the involvement of the potential users, and, as such, their needs and goals. Additionally, it was also verified that most applications disregarded the possibility of the users being undertaking treatment in clinical establishments, which led to the neglect of data collection and communication features that could aid the clinical practice.

Taking into account the previously mentioned benefits and main concerns of digital delivery of mental health treatments for anxiety, a tentative roadmap is presented pointing out the facts and possibilities that could be considered to overcome its current difficulties.

First of all, assuring a good level of app engagement is crucial to guarantee the users' therapy conclusion, especially if the therapy method consists of an unguided one. With this in consideration, some principles have already been explored, such as "gamification" in the app proposed in [17], which consists of the use of game design elements in non-game contexts to make the app more enjoyable to a big segment of users.

Another core necessity to be considered by any type of medical app is that their proposed therapies should be based in scientifically proven principles, since their objective is to help users in their lives and not further complicate them. Even though some therapies have already been proven to be successful at helping users manage their anxiety levels, as noted in [36, 38], CBT is the one mostly considered, consisting in a therapy that aims at identifying harmful thoughts, assess whether they are an accurate depiction of reality, and in case they are not, employ strategies to challenge and overcome them.

Considering that medical data is highly private and sensitive, it is important to guarantee its security and privacy [13]. Currently, the most common mechanism to preserve it is allowing the users to decide with whom and how they want to share it.

Treatment customization is an aspect that should as well be considered since most of the proposed treatments are delivered in a standardized way, not allowing their adaptation for individuals that suffer from different types of anxiety disorders. Besides treatment customization, it has already been proposed in other studies, such as in [39] and [19], the inclusion of sensing technology to facilitate the user's assessment, and, most importantly, increase the app's accessibility through the inclusion of other communication modalities, which may help in overcoming the problem of some people not having the capacity to interact with the application due to certain disabilities they might have, or enabling its use in a wider range of contexts.

Randomized Controlled Trial (RCT) is considered as the golden standard of research, being mostly performed for assessing the app's treatment effectiveness [40]. However, although regarded as the golden standard, it typically takes 5.5 years from its enrollment to its publication. This is a problem that critically needs to be dealt with because, since technology is constantly evolving, at a really fast pace, there is an inherent risk that by the time the apps are proven to be effective their technology has already become obsolete.

As proposed in [41], a final consideration that needs to be tackled is the design and development of the apps regarding the needs and motivations of both the patients and clinicians, since, typically, they are oriented at satisfying the needs of only one of them.

In light of all these verified concerns and corresponding possible solutions, the adoption of an iterative user-centered approach, to design and develop the proposed tool for digital delivery of anxiety treatments, might be highly beneficial. Since this approach gives extensive

attention to which user needs and motivations to consider, along with usability goals, at each stage of the design process, the resulting tool will not only satisfy all the requirements deemed necessary for both the clinicians and patients but also have an appropriate level of usability as well. With the appropriate user involvement throughout the design process, via a variety of research and design techniques [42], many of the enumerated concerns will eventually be tackled, such as the aspects of user engagement, treatment customization, and, by an understanding of the scenarios of interest, a definition of relevant sensing technologies and additional communication modalities to increase adaptation.

Since all these mentioned considerations and goals cover a broad spectrum of contexts and scientific areas, an early collaboration between multidisciplinary teams is required to achieve an effective translational research for mental health assistive technologies. Thus, as depicted in Figure 2.1, the successful implementation of these technologies consists in the intersection of multiple complementary research areas.

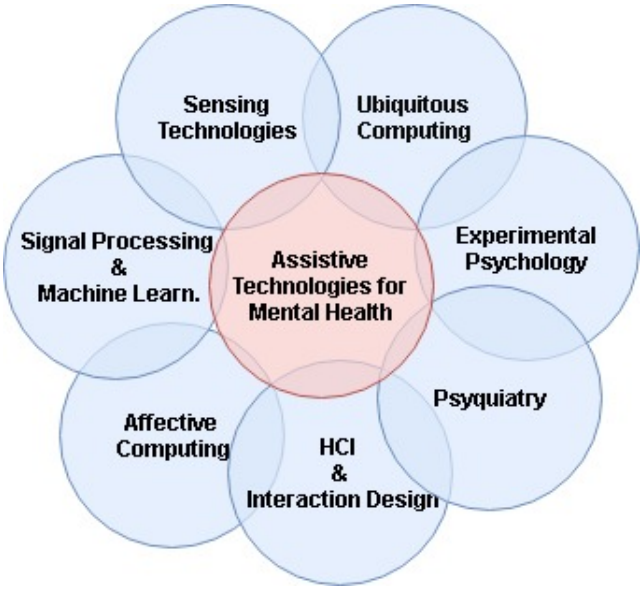


Figure 2.1: Proposed intersection of multiple complementary research areas for the proposal of assistive technologies for mental health. Figure adapted from [41].

2.3 Development of Multimodal Interactive Systems

The long term effort needed to pursue the previously proposed roadmap requires the adoption of an overall architecture that can support contributions at different levels. One important aspect to take into account pertains to how the users will be able to interact with the assistive systems, particularly considering that an adaptation to different scenarios, tasks, and audiences might be paramount.

The benefits that are inherent to the consideration of multiple modes of communication between users and interactive systems have fostered the research and development of multimodal interactive systems. Besides allowing the users to interact with systems by using

other modalities, such as speech, touch, and gestures, they can still increase accessibility by enabling their use by a wider audience or in a broader range of contexts [43].

The development of multimodal interactive systems is a complex task, and a major effort has been done, by the W3C consortium, in proposing an architecture and a set of standards to support multimodal interaction (MMI) [44].

A few frameworks have been proposed to support the development of MMI systems, such as HephaisTK [45], OpenInterface [46], MUDRA [47], and AM4I [48]. One distinguishing characteristic of the latter is that it is based on the open standard for MMI, which was proposed by the W3C. A simplified model of the architecture is presented in Figure 2.2. The most notable aspect of the implemented architecture is that the different modules are fully decoupled: a set of modalities communicate, using a standard markup, with a central Interaction Manager. The application logic receives and sends messages to and from the modalities also by communicating with the Interaction Manager [48].

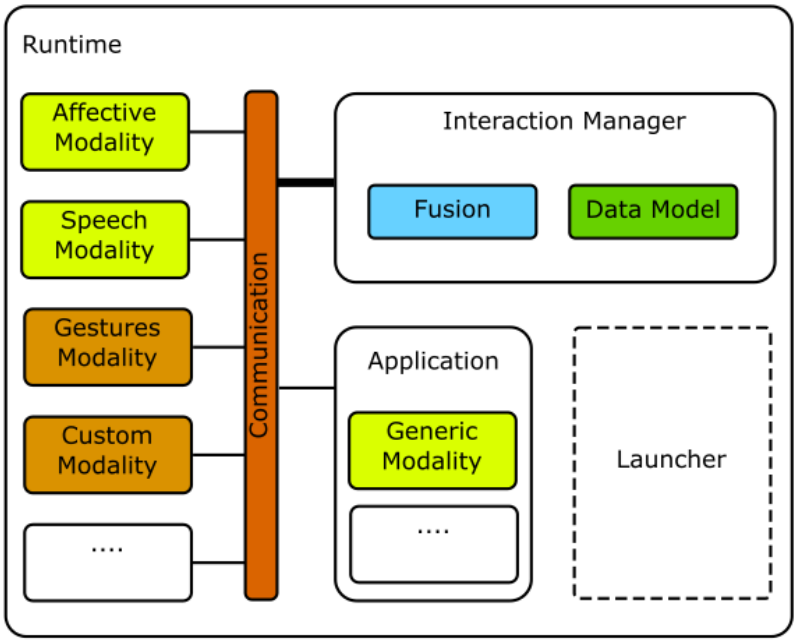


Figure 2.2: Multimodal Interactive Architecture.

The consideration of a framework reduces much of the work required to deploy interactive systems and allows the fast creation of new applications. One of its key aspects is the decoupled and modular approach: by configuring a new application with the requirements that are needed to communicate with the framework, it can immediately take advantage of its capabilities. For instance, the framework already provides an off-the-shelf modality to support speech interaction, where the developer only has to configure a few parameters with no need to master the development of speech synthesis and recognition logic. Also, the framework includes multi-platform and multi-device interaction capabilities, enabling the use of different devices, simultaneously, to interact with one application [49].

One of the interesting aspects of AM4I is that it explicitly embraces the concept of generic modalities. A generic modality, like other modalities, enables interaction with the system. Additionally, these modalities are an integral part of the framework, i.e., they come off-the-shelf when the framework is adopted and allows developers to easily deploy them with little to no effort to configure them. One notable example of a generic modality, which is already part of the AM4I framework, is the speech modality [50].

In this regard, any effort that results in a generic Affective Modality, which can be integrated within the framework and, thus, made available to all systems that adopt it, is an important step to bring affective interaction to a broad range of applications.

2.4 Discussion and Conclusions

Considering the inherent potential of anxiety apps to enhance the access to mental health care, there has been a huge private investment in their development to increase and improve chronic disease management. Unfortunately, even though commercially available anxiety mHealth apps are abundant, there is still a clear gap between their commercial availability and their proven efficacy and effectiveness [51].

While psychophysiological studies have been continuously uncovering valuable data that could be harnessed to improve how mental health care is delivered, there are still a lot of concerns that need to be addressed to translate that knowledge into efficient tools that are capable of aiding users in their daily life.

This overview highlights the main problems that need to be tackled and reinforces that a major effort is needed to bring forward a swift path from innovative research into personalized and preventive systems that can assist users in their daily anxiety management necessities. So that this can be achievable, the work to be carried out should adopt a UCD approach, consider the advantages of adopting a multimodal architecture supporting interaction, and consider the collaboration of a multidisciplinary team since its inception.

CHAPTER 3

Personas, Context Scenarios, and Requirements

One of the main factors why user-centered design approaches are highly effective in the development of systems is that the resulting product, and its inherent development decisions, are not being based around the assumptions of the design and development team but built around the users' expectations and needs. Only with methods such as focus groups, interviews, and research, we can truly and deeply understand the users to which our application will be oriented and guide the system's development process accordingly, so that their needs and expectations can be met. With this said, the requirement elicitation phase is crucial to determine the success or failure of a project and, therefore, must be performed in a complete and clear way. In light of these considerations, this chapter serves the purpose of detailing and describing the different steps that were taken to propose the initial set of requirements, which served as the foundation for the development of the proposed system. It is also important to note that, to carry out these steps, and in an attempt of achieving a truly translational research in mental health assistive technologies, a multidisciplinary team was considered, being composed by Psychologists, Human-Computer Interaction (HCI) and Software Engineers, and Engineering and Psychology students.

A brief overview of the multidisciplinary effort to obtain a characterization of the target audiences and contexts, described in this chapter, has been submitted to an international conference:

- *David Ferreira, Daniela Melo, Pedro Silva, Andreia Santo, Nuno Madeira, Sandra C. Soares, Samuel Silva, "Supporting Anxiety Management through mHealth: Methods and First Contributions Considering the Academic Campus", submitted to the 28th European Congress of Psychiatry, 2020*

3.1 Identifying users and their motivations

In order to characterize the proposed system's different types of users, as well as their corresponding motivations, the team resorted to the definition of 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 them to focus their attention on what really needs to be designed and developed to help the users in achieving their goals [42]. Considering this necessity to understand the needs and goals of each individual, each Persona has a description of its corresponding motivation, since the retainment of that knowledge fosters the creation of user-centered systems. One additional advantage of using Personas, in this process, is that their narrative form helps on multidisciplinary dialogue, improving the outcomes of the discussions [52].

Due to the vast list of contributions that the characterization of Personas can bring to the development of a system, and it being inherent to the UCD approach, the team resorted to this technique to obtain the set of requirements to support users in managing anxiety.

In this sense, to obtain the necessary information for the definition of the Personas to be initially proposed, an analysis of the literature concerning the characterization of the different types of university students and teachers was carried out, with a particular focus on their specific needs and challenges. Additionally, literature concerning the characterization of a clinician in the university context was also considered, highlighting its main challenges, proposed techniques, and needs.

In a first attempt to characterize the different types of users of the proposed system, the team resorted to brainstorming sessions, where several aspects regarding the problems, the users, and the application domain, were discussed. The data collected in these sessions, along with the information that resulted from the initial literature review, justified the creation of five Personas, all deemed relevant for an appropriate characterization of the application's context and its potential users.

To improve the initial version of the proposed Personas, two focus groups were performed: one with academy students, and another with teachers. In the first session, elaborated with students in a higher education context, it was verified that not only the problems associated with the rise of their anxiety levels were important to be dealt with but also those related to their time management and integration in the academic environment, since they were equally identified as being great sources of anxiety. As a consequence of these verifications, some changes were made to the initially proposed Personas, so that the future, resulting, requirements could reflect and attend these additionally considered needs. A similar session was performed with teachers of higher education, and it was verified that, apart from the specific situations that are typical generators of anxiety, such as evaluations and class giving, time management problems were also considered to be relevant indirect contributors to the

rise of their anxiety levels.

From both focus groups, and the performed brainstorming sessions, the following Personas resulted:

- **Rute**
  - Rute Persona is depicted in Table 3.1, and it represents 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.
- **Mafalda**
  - Mafalda Persona is depicted in Table 3.2, and it represents an undergraduate student who is afraid of speaking in public, suffering from severe anxiety attacks whenever she needs to do so. Given the circumstances, she ends up isolating herself, which makes it even harder for her to integrate into the academic context. As such, she would like to have support at her disposal, so that she could freely speak in public without suffering from the consequences that are inherent to such adversity.
- **Henrique**
  - Henrique Persona is depicted in Table 3.3, and it represents an undergraduate student who misses his friends in his hometown. As such, he would like to meet people who are in the same situation as him, not only to create new friendships but an environment of mutual assistance as well.
- **Carlos**
  - Carlos Persona is depicted in Table 3.4, and it represents a teacher whose main anxiety source results from his inability to manage its own schedule in an efficient way. As such, he would like to have at his disposal an approach that would both, provide him with relaxation techniques to allow him to relieve the stress of his daily life, and that would manage his schedule in the most adapted and efficient way as possible.
- **Margarida**
  - Margarida Persona is depicted in Table 3.5, and it represents a Psychologist who works in the academic context. Given that she caters a large number of different people, she has some difficulty in monitoring all their corresponding progresses. As such, she would like to have a tool capable of recording all the data from her different patients, allowing her to verify their progresses at the beginning of each appointment.

Table 3.1: Persona of Rute, an Undergraduate Student.

Image adapted from https://pxhere.com/en/photo/1456591.

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 feels a tightness in the chest. Sometimes, during the course of her exams, these symptoms are accompanied by blanks, which consequently prevent her from applying the knowledge 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.

Table 3.2: Persona of Mafalda, an Undergraduate Student.

Image adapted from https://pxhere.com/pt/photo/1448341.

Mafalda is 21 years old and is currently completing the third year of her degree in Psychology, at the University of Aveiro. Considering that Mafalda always avoided situations that required public speaking, she now exhibits fear of both, being negatively evaluated, and experiencing social rejection. When this turmoil of feelings and thoughts occurs, Mafalda begins to tremble, to sweat from her hands, and her heart starts to race. Moreover, Mafalda considers that her struggle in communicating hampers her ability to interact with the rest of her classmates, exhibiting a perception of a cold and distant person, when, in reality, she is a pleasant and friendly girl. Currently, one of her main concerns is the possibility of pursuing a master's degree, something that is indispensable in her area. However, the need to present a master's dissertation induces some ambivalence in her decision, interfering, once again, with her academic performance and well-being.

Motivation: Mafalda would like to freely communicate in public to better relate herself with her colleagues, consequently improving her social life, and accomplish the proposed tasks in her following academic years, including the submission of her master's dissertation.

Table 3.3: Persona of Henrique, an Undergraduate Student.

Image adapted from https://pxhere.com/pt/photo/773318.

Henrique is 19 years old and is currently completing the first year of his degree in Modern Languages, at the University of Aveiro. Although Henrique is a native of Bragança, he preferred to stay in the campus residences during his academic year. However, and considering the distance between both cities, his social life suffered some major changes, since most of his friends either went to other universities or started to work. Nowadays, Henrique's new responsibilities, such as taking care of his residential space, and organizing a consistent routine, limit his social interaction time. As such, Henrique's major concerns are the lack of knowledge regarding the city where he now lives, and the lack of support for his problems and concerns, something which used to be provided by his previous group of friends.

Motivation: Henrique would like to meet other students who are, or have been, in the same situation as he is, in order to better adapt himself to this new stage of his life.

Table 3.4: Persona of Carlos, a University Professor.

Image adapted from https://pxhere.com/en/photo/1169779.

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 his daily routines.

Table 3.5: Persona of Margarida, a Clinical and Health Psychologist.

Image adapted from https://pxhere.com/pt/photo/266372.

Margarida is a 50 years old Clinical and Health Psychologist, who has worked at the Health Center of the University of Aveiro for 20 years. She is highly interested and dedicated to helping the entire academic community. During her free time, she enjoys doing activities, such as going to the gym, traveling with her family, and learning about some new cultures. As a psychologist in the university context, she regularly caters several students and teachers per day, who often exhibit anxiety-related difficulties. One of Margarida's main difficulties is to monitor the progress of all the patients to whom she provides services, due to how vast their number is. Margarida would not mind replacing the current, standard, monitoring and follow-up procedure for a more versatile, and easier to use, technology-supported alternative.

Motivation: Margarida would like to improve the way that she monitors her patients during her clinical practices.

3.2 Context Scenarios

Context Scenarios can be seen as a way to describe how a user can be supported in a particular tasks or context. It is an excellent tool to determine how a system can properly integrate the user's activities so that their needs can be successfully attended [42]. In an attempt to understand the different ways in which the anxiety management tool could be used, several context scenarios were developed, which were subsequently reviewed by clinicians that guaranteed their validity in terms of applicability, and, consequently, the plausibility of the system to be developed. Although several context scenarios have been proposed, for the sake of brevity, only four will be illustrated below, being the remaining ones included in Appendix A. It is also important to note that the developed context scenarios resulted from the performed focus groups, having been considered the typical contexts from the previously identified target audiences.

The first scenario, presented below, represents the first contact that Henrique has with the application. It is made sure that he understands the features that the anxiety management tool supports, and an initial inquiry is made so that the application can learn about his daily habits and adapt itself to the gathered information.

Henrique interacts with the system for the first time — *Henrique uses the system for the first time and is faced with a welcome message that informs him about the available features. To interact with the system, first, Henrique needs to create an account, and, only then, he is able to login with the registered information. After signing in, he is asked to complete a short questionnaire that allows the system to learn about his preferences, consequently adapting itself,*

and its features, to the student's profile. This short questionnaire consists of multiple-choice questions, in which Henrique only needs to point the ones to which he relates himself.

The second scenario represents a situation in which the application detects an increase of Rute's anxiety and proposes the execution of a diaphragmatic breathing exercise. With this, the application guides her throughout each step of the technique and emits a vibratory alert to signal the transitions between breathing cycles.

Rute performs diaphragmatic breathing a few moments before an exam — *The last exam of this semester will start in 15 minutes. Given the accumulation of tiredness, anxiety, and study content that is required for this evaluation, 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 evaluations. 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 evaluation, 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.*

The third scenario represents a situation in which Carlos recognizes that he needs to relax, and to do so, he decides to perform a progressive muscle relaxation technique. As such, he is guided throughout each step of the technique with the help of voice instructions.

Carlos performs progressive muscle relaxation after a day of work — *Carlos arrives home after a long day of work. Considering that he is still quite tense and anxious, due to the overload of tasks and stressful situations with his students, he decides to resort to the anxiety management system. Considering that his family will only return home in the next hour, he decides to perform a progressive muscle relaxation technique of 16 muscle groups. Therefore, the system requests Carlos to sit in a comfortable position and to focus his attention on the muscle groups that are progressively indicated to him. To help him monitor the different cycles of muscle contraction and relaxation, the system provides a human voice guide to lead him throughout the entire session. After this process, Carlos feels less anxious and more relaxed, as it was intended.*

Lastly, the forth scenario represents a situation in which the application detects an increase of Rute's anxiety and proposes the execution of a mindfulness exercise. As such, the application guides her throughout each step of the technique with the help of voice instructions.

Rute performs a mindfulness technique during her study session — *Rute is faced with another study blockage during one of her study sessions. Since her anxiety management system detects that she may be experiencing high levels of anxiety, it suggests her to perform a mindfulness exercise. Before the technique's initiation, the system advises her to sit comfortably and to close her eyes, indicating, as well, that she should direct her attention to her auditory sense. After following the initial steps, Rute puts her headphones, which, in addition to the ambient sounds surrounding her, allows her to listen to the provided system's audio guide. The system suggests that she should initially listen to the sounds closest to her, and then, progressively, start focusing her attention on the remaining and increasingly distant sounds. Throughout the technique, Rute feels more and more relaxed, and returns to her study session as soon as the exercise is complete.*

3.3 Requirements

Attending to the diversity of scenarios and the nature of how anxiety manifests itself, the team resolved that the ideal way to support the several existing audiences in managing anxiety was through the consideration of an mHealth approach. To ensure the appropriate development of the proposed system, and to establish a foundation for its development guidance, a requirement elicitation phase was considered. As such, and as a result of all the performed brainstorming and focus group sessions, as well as the established context scenarios, several requirements were identified as being necessary for the appropriate development of the proposed system, being these requirements presented in Table 3.6. Regarding the extracted requirements, a prioritization was subsequently made to assure that a prototype deemed adequate to undergo first tests with users in stressful situations would be attained. This version would allow usability evaluations to be carried out as well as assessments regarding the impact that its proposed techniques would have on the users' anxiety levels.

It is worth mentioning that the assessments that were carried out, along the different development iterations, did not show the need for changing any of the initially proposed requirements but contributed to improve how they were being developed, which further confirmed the validity of the captured users' necessities. It is also important to note that, although the list of extracted requirements remains the one that was initially proposed, it might be subject to changes or refinements during the iterative development of the system, since there is an inherent possibility for the addition of new requirements or alteration of previously considered ones.

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

Table 3.6: Set of requirements identified for the envisaged mHealth system to support anxiety management.

3.4 Discussion and Conclusions

This chapter briefly describes the work carried out for identifying and characterizing the potential application's users and their corresponding motivations and needs. To this end, a multidisciplinary team was formed, including Psychologists, HCI and Software Engineers, and Engineering and Psychology students. Focus groups were as well performed to involve the end-users in the improvement of the initially proposed Personas and, additionally, in the definition of the various contexts that served as the foundation for the established scenarios. With the definition of the context scenarios it was possible to elicit a set of initial requirements to guide the appropriate development of the proposed system.

An important aspect that was mentioned, and highlighted throughout the chapter, was how central UCD approaches are to determine the motivations and needs of the potential application's users, being that, only with this knowledge, it is possible to properly guide the development of the proposed system so that those needs can be successfully attended.

CHAPTER 4

Application Development

Since an iterative UCD approach was considered for the development of the proposed anxiety management system, it is important to understand that different design and development stages were deemed necessary to guarantee both, an appropriate focus on the needs and requirements of its end-users, and an adequate orientation of its development process. In this chapter, not only the application is detailed but its entire development life cycle as well, since it is paramount to understand the considerations and methods that were taken into account in order to guarantee its validity and appropriate development. In particular, and considering the initial subset of requirements, three prototypes were elaborated and were subject to user assessment, being the result a prototype deemed adequate to undergo first tests with users in stressful situations. All these iterations will be explained, along with a summary of the outcomes of each evaluation.
At the time of preparing this document, part of the work described in this chapter had already been accepted for presentation in an international conference:

- *David Ferreira, Daniela Melo, Andreia Santo, Pedro Silva, Sandra C. Soares, Samuel Silva, "Stop Anxiety: Tackling Anxiety in the Academic Campus through an mHealth Multidisciplinary User-Centred Approach", Proc. MobiHealth 2019 – 8th EAI International Conference on Wireless Mobile Communication and Healthcare, Dublin, Ireland, November 2019;*

4.1 System Architecture

To consider additional modalities, and obtaining affective states in the context of the proposed application, a multimodal architecture was adopted, being the AM4I framework considered for supporting its development. Regarding such considerations, some modules had to be adapted and developed to enable the adoption of such architecture.

The AM4I is a framework for supporting multimodal application development, offering a set of off-the-shelf interaction modules and modalities that developers can add to their applications

[48]. Through the adoption of such framework, and the consideration of a multimodal architecture, it is possible to ensure the easy integration of any additional modalities, and, as such, the reception of affective inputs regarding the application users' emotional states, something which can be highly advantageous given the considered application's purpose.

4.2 First Iteration: Paper Mockup Development

This iteration comprised the development of a paper mockup, that resulted from the list of extracted requirements presented in Chapter 3, which, after being validated, served as the foundation for the application's implementation. In addition to the summarized presentation of the mockup, the list of improvement suggestions, which emerged from the elaborated brainstorming sessions, is also described.

4.2.1 Paper 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 [53]. Its great advantage is that it allows making quick and cheap changes to the prototype rather than to the system already developed, being that, in the latter case, there would be greater difficulties and costs associated. In light of these considerations, the initial step for the development of the first functional prototype was to make a paper mockup of its interface, being an example depicted in Figure 4.1, and, for the sake of brevity, the full version can be found in Appendix B. This figure illustrates the menu in which the variants of each technique can be chosen, from left to right: the menu responsible for the Mindfulness technique, the menu responsible for the Progressive Muscle Relaxation technique, and the menu responsible for the Diaphragmatic Breathing technique.

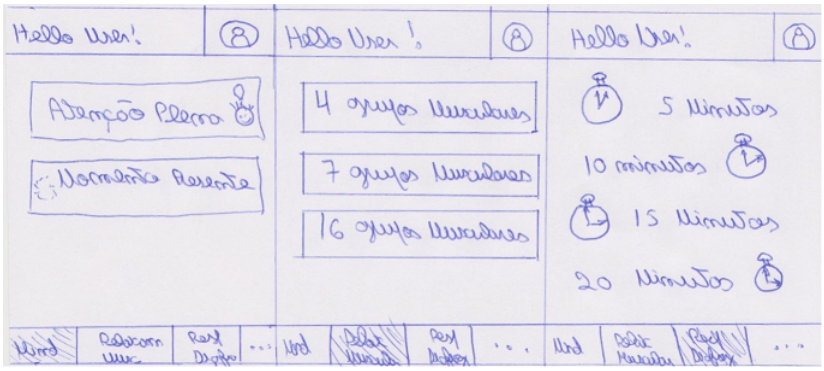


Figure 4.1: Paper Prototype example. From left to right: the menu responsible for the Mindfulness technique, the menu responsible for the Progressive Muscle Relaxation technique, and the menu responsible for the Diaphragmatic Breathing technique.

4.2.2 Paper Mockup Validation

Once done, the sketches were evaluated in a brainstorming session including all members of the multidisciplinary team, having been validated, apart from a particular aspect regarding how the users' progress would be presented. Concerning this aspect, it was suggested that, instead of presenting the users with their possible lack of progression or failures, it would be more beneficial to only present them their positive evolution, that is, even if they would not successfully carry out the proposed activities, they would still not be penalized in their progression, and, at most, their stats would remain the same (Figure 4.2). By doing so, their motivation would not be as negatively influenced, and their progress would be continuous, although at a slower rate in case of real regression.

Figure 4.2: The users' statistics screen: the first version of the mockup (on the left) was changed to provide a more positive look over the user's performance with the application.

4.3 Second Iteration: Paper Mockup Transposition Into a Preliminary Application Version

The main goal of this iteration was to have a first instance of the overall interaction approach to allow initial assessments. Some illustrative screen layouts for this initial version are presented, as well as the results of the first elaborated evaluation.

4.3.1 Prototype Development

The first functional prototype implemented a refined version of the approved paper mockup, leaving out the full implementation of the exercises. It is important to note that the development of this initial prototype was based on the prioritized list of initial requirements. However, even though the anxiety reduction techniques have not yet been implemented in this prototype, the layout structure for their incorporation has already been established. That being said, the overall flow was quite similar to what was envisaged for the full application. Figure 4.3 depicts some examples of the layouts that resulted from the development of this first prototype instance. On the left side of the figure is presented the initial menu from where the user can select the multiple application's main features, while on the right side is illustrated an example of the menu responsible for the techniques' variants selection, in this case, regarding Mindfulness. It is crucial to mention that the design of the applications' layout was focused on the users' needs and motivations, putting them at the center of the action, since it is what they want that matters. An example of this can be observed on the left side of the figure, where instead of presenting the users with an exhaustive list of the available sections of the application, we attempt to make them feel they are choosing an experience aligned with their feelings and motivations. For instance, instead of a button for "Relaxation Techniques", users choose that it is time to relax.

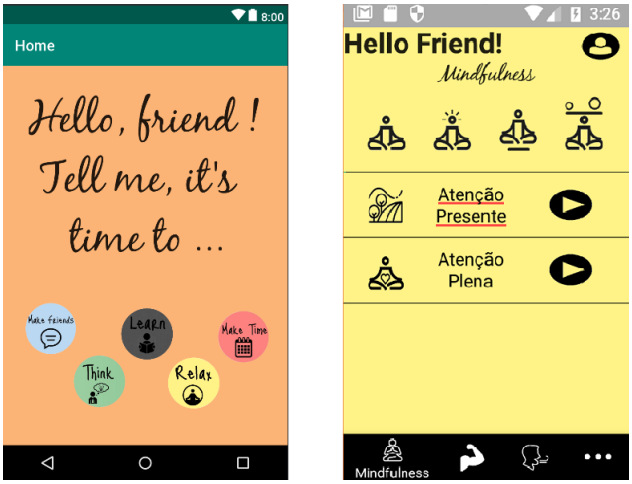


Figure 4.3: First illustrative layouts.

4.3.2 Heuristic Evaluation

Considering the early stage of development, our first goal was to detect any major usability issues. Therefore, the first prototype was subjected to an heuristic evaluation, considering the Nielsen's heuristics [54], so that potential usability problems could be detected and, subsequently, resolved in the future developments. Five evaluators, three males and two females, aged between 22-24 years old, Computer Science students, with previous experience in performing 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.

Regarding this evaluation, so that the respondents could report, for each heuristic, problems that were inherent to them, as well as possible implementation alternatives for the identified problems, a form was elaborated (please refer to Appendix C for the complete form). In this assessment, problems related to four different categories were identified:

- **Lack of Feedback**

  There was a lack of feedback whenever fields were incorrectly filled in, and when the user's personal information was updated.
- **Design and Aesthetics**

  At many times, users felt lost in the application and required additional guiding information to understand some of the app's functionalities. Many color and icon inconsistencies, between different layouts, were detected, as well.
- **Functional**

  Some core functionalities were missing, such as the possibility of undoing information changes, selecting some initial configurations of the techniques yet to be implemented, and logging out of the application. Another identified problem was that, whenever the application was put in background, resources would still be continuously consumed from the mobile.

- **Facilitators**

  Facilitating aspects, such as saving the last user's email, in order to allow him to log in faster, or shortcut buttons, to skip guiding tips, were missing.

After enumerating all the identified problems and their respective proposed solutions, it was then started the development of the second prototype.

4.4 Third Iteration: Second Prototype Development Considering the Last Assessment's Issues

This iteration concerns the development of the second prototype, taking into account the registered problems and correspondent implementation suggestions, and its subsequent usability evaluation. Firstly, a description of the considered functional and design changes is presented, followed by a discussion of the used evaluation tools for the prototype's usability assessment. Once again, the development of this prototype focused on the motivations and needs of the users, as well as the list of extracted requirements that guided its entire development process.

4.4.1 Prototype Development

Given the encountered problems in the heuristic evaluation of the previous prototype, changes were made to tackle them to potentially improve the usability of the application. As such, and taking into account the identified problems, the measures taken to address them were:

- **Lack of Feedback**

  In light of the various complaints regarding the lack of feedback that was given to users, while using the application, it was ensured that for each task execution, information related to its conclusion, either it being successful or unsuccessful, would be presented. Depicted in Figure 4.4 are examples that illustrate the feedback that is provided by the application, with the intent of helping its users in successfully achieving their goals. Even in case of failure, the application provides immediate feedback that identifies the specific error, providing the user with information that allows him to understand the causes of the problem he encountered.
- **Design and Aesthetics**

  Considering the lack of orientation that users reported during the use of the application, both the need to provide more information, and to make it more visible, were addressed. One of the main identified problems was that, although additional information was presented as soon as a technique was selected, no information was given to the users before they actually selected it, which would prevent them from making a conscious choice of the technique they would like to perform. As such, it was decided to give users the opportunity of obtaining initial information about the techniques in the menu in which they are available, without needing to previously select them (Figure 4.5).

  Another identified problem consisted in the absence of information concerning the progress bar during the course of the selected technique, since it was not properly visible,

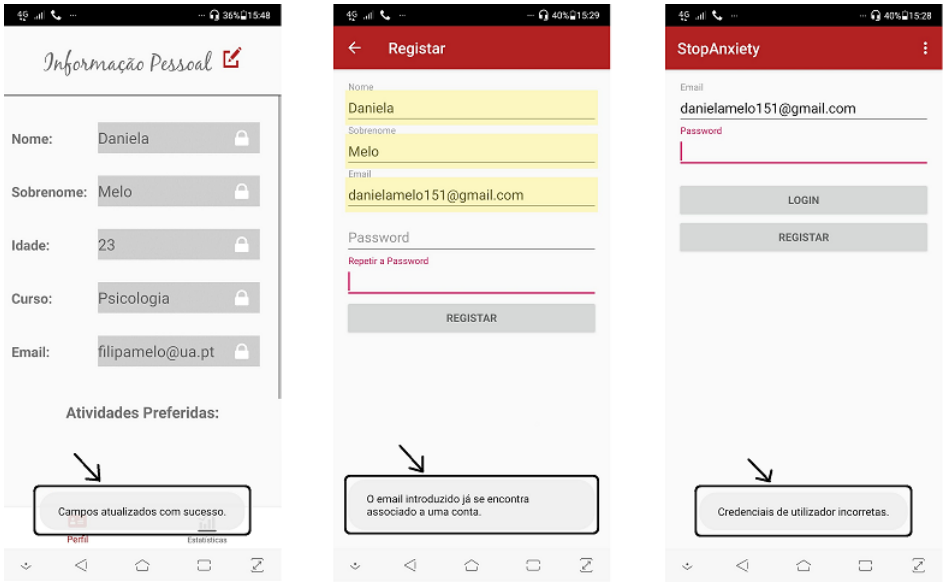


Figure 4.4: Application's feedback. From left to right: feedback regarding the update of the user's personal information, feedback notifying the user that the email he is trying to register himself with already exists, and the feedback notifying the user that the password does not match the inserted email.

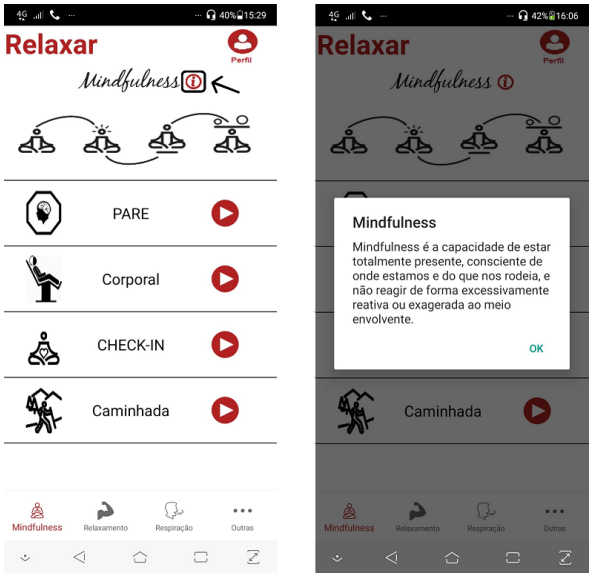


Figure 4.5: Additional technique's information. The button responsible for presenting the additional information concerning the Mindfulness technique (on the left) and the information that is correspondingly shown.

and its function was not clear. In this sense, an icon was added, with the purpose of clarifying that the bar was associated with the progression of time, and its size was increased, so that it would become more visible. The above-mentioned changes can be seen in Figure 4.6.

Attending to the difficulty expressed by the users in identifying the function of some of the used icons, a textual designation was added to them so that they would be more easily interpreted. In Figure 4.7 are presented two examples in which this issue was

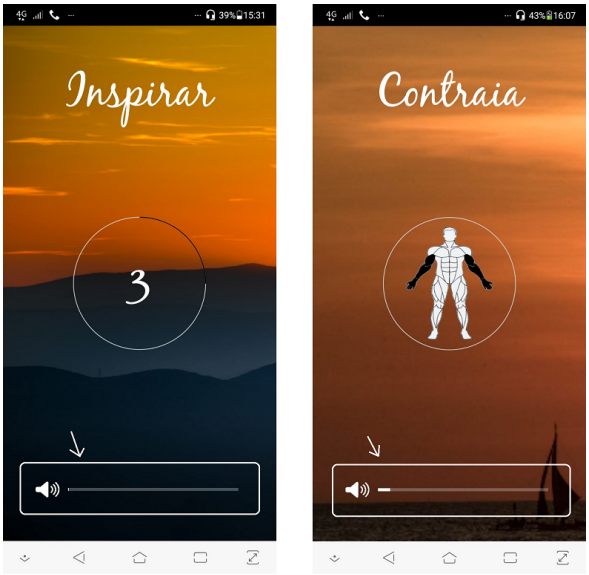


Figure 4.6: Technique progression bar. The progression bar that depicts time progression until the Diaphragmatic Breathing treatment's conclusion (on the left), and the bar that depicts time progression from the Progressive Muscle Relaxation technique.

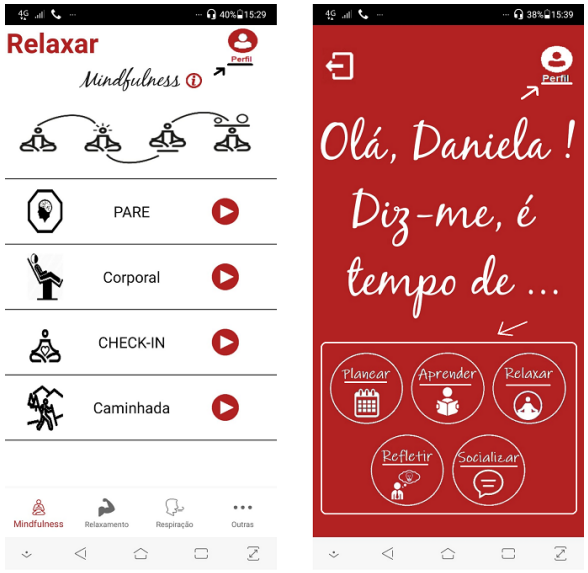


Figure 4.7: Additional icon descriptions. A textual description was added to some icons so that they could be more easily interpreted.

addressed.

- **Functional**

  Throughout the heuristic evaluation, it was verified the absence of some necessary functionalities to provide an adequate experience to the users. The aspects that were missing, and which were consequently implemented, consisted in a button to log out of the application, a button to register a new user, without having to resort to the upper navigational bar, and a button to select the type of intended guide, whether it being audible or vibrational (Figure 4.8).

- **Facilitators**

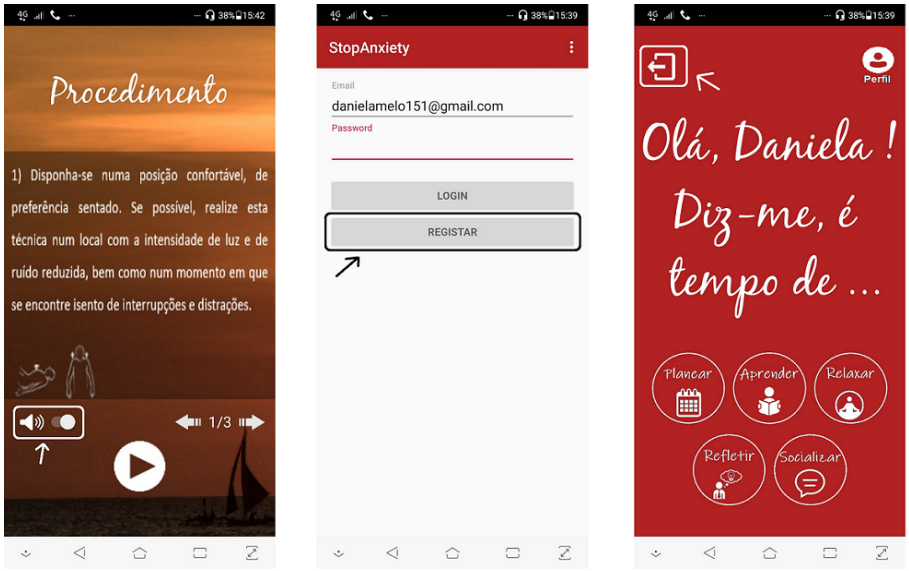


Figure 4.8: Additional functionalities. From left to right: The option to select the type of intended technique's guide, the option to register a new user without needing to resort to the upper navigational bar, and a button to log out of the application.

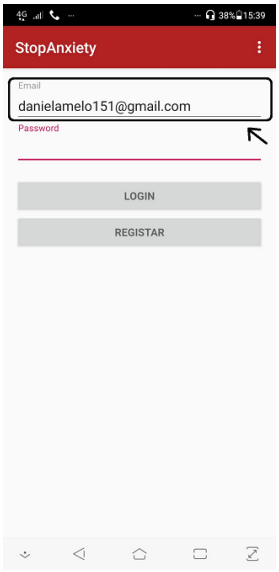


Figure 4.9: Last user's email. So that the user would not be constantly required to type his email every time he intended to login, the last used details were kept.

Finally, regarding the users' interactions with the application, there was a need to include some facilitators to promote greater speed and effectiveness in achieving some of their goals. On the one hand, it was considered important to keep the last user's email stored, so that he would not be constantly required to type his email every time he intended to log in (Figure 4.9). On the other hand, in order to facilitate the interpretation of the technique's guide, a slideshow style was adopted, making it more interactive, and enabling the users to visualize, step by step, the required instructions for the appropriate execution of the technique to perform (Figure 4.10).

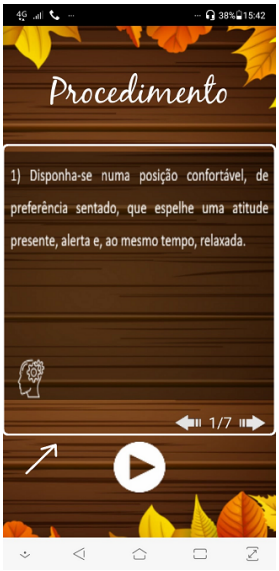


Figure 4.10: Technique's guide. A slideshow styled technique's guide was adopted, making it more interactive, and enabling the users to visualize the required instructions for the appropriate execution of the technique to perform.

After the implementation of all the referred aspects, the development of the second prototype was concluded.

4.4.2 Usability Evaluation

With the conclusion of the second prototype's development a change of focus was made for its evaluation, so that, possibly, additional usability problems could be found. This time, the intent was to discover usability problems while users were using the application to reach concrete goals. As such, a Think Aloud protocol was implemented where people were asked to perform specific tasks, by using the application, while giving feedback of what they thought and the difficulties they faced. For this evaluation, five participants were considered, different from those that performed the heuristic evaluation, four males and one female, aged between 22-25, and all of them Computer Engineering students with experience in mobile applications use and development.

Regarding the selection process of the tasks to be performed in this assessment, concrete usage contexts of the already developed features were considered, resulting in the definition of a set of 10 tasks. Additionally, concerning this evaluation, the quantitative metrics deemed relevant for registration were: the success/unsuccess in performing the tasks, the time to completion in seconds, and the number of errors and unforeseen events during their execution. The list of proposed tasks is illustrated in Table 4.1, and the sheet used to record the information is present in Appendix D.

In addition to the registration of the quantitative measures and observed difficulties with which the participants were faced, some post-study questionnaires were also applied:

- **System Usability Scale (SUS) [55, 56]:** A reliable tool that consists of 10 evaluation items, each of which has five response options that vary between Strongly Agree and

Tasks	Success/Unsuccess	Time in Seconds (Average)	Errors (Average)	Unforeseen Events
Register in the application.	5/0	30.8s	0	-
Log in to the app.	5/0	3.6s	0	-
Edit and complete your profile.	5/0	35s	1.2	Difficulty in finding the button to turn the profile information changes permanent.
Get more information about the Muscle Relaxation Technique.	5/0	27.4s	0	Difficulty in finding the menu that corresponded to the Muscle Relaxation Technique
Setup the Diaphragmatic Breathing Technique for a duration of 7 minutes.	5/0	7s	0	-
Select the mute option in the Diaphragmatic Breathing Technique menu.	5/0	2.8s	0	-
Perform the Technique for approximately 1 minute.	5/0	-	0	-
Return to the menu of the Diaphragmatic Breathing Technique and perform it with sound.	5/0	6.2s	0	-
Perform the Muscle Relaxation Technique by contracting and relaxing one of the indicated muscle groups.	5/0	-	0.6	Difficulty in reading the procedure that was inherent to the technique
Log out of the application.	5/0	6.8s	0.2	Difficulty in finding the Logout Button

Table 4.1: Observational results table (Third Iteration).

Strongly Disagree. It is a very easy scale to use and is capable of both, effectively differentiate a system between being usable or unusable, and obtain reliable results even when applied in small samples of participants.

- **Post-Study System Usability Questionnaire (PSSUQ) [57, 58]:** This scale consists of 19 evaluation items, each of which has seven response options that vary between Totally Agree and Totally Disagree. Additionally, for each item, there is still the option of not responding, for cases where the item is not applicable to the application under assessment. Although PSSUQ is longer and more complex to perform than SUS, it allows a more complete analysis of the usability of the system.

For this assessment, and although SUS and PSSUQ are very similar tools, they were both considered for confirmatory and answer incongruity detection purposes.

Regarding the obtained results from the above-mentioned procedure, a table was developed, being depicted in Table 4.1, with the purpose of summarizing and presenting them for each of the considered tasks. It should be noted that, although all the participants were capable of successfully completing all the 10 proposed tasks, there where some aspects, in four of the tasks, where some difficulties were encountered:

- In the task of editing the users' profile, given that their information was visually inserted in a gray rectangle, the participants intuitively clicked on it, to edit their profile, instead of the button where they were supposed to. In this same task, when the participants wanted to finally submit their profile changes, they were faced with some difficulties in doing so, since they could not find the correct button to apply them. As a last consideration, it was suggested that the profile icon should as well be available in the initial menu so that the profile area could be more easily accessed.

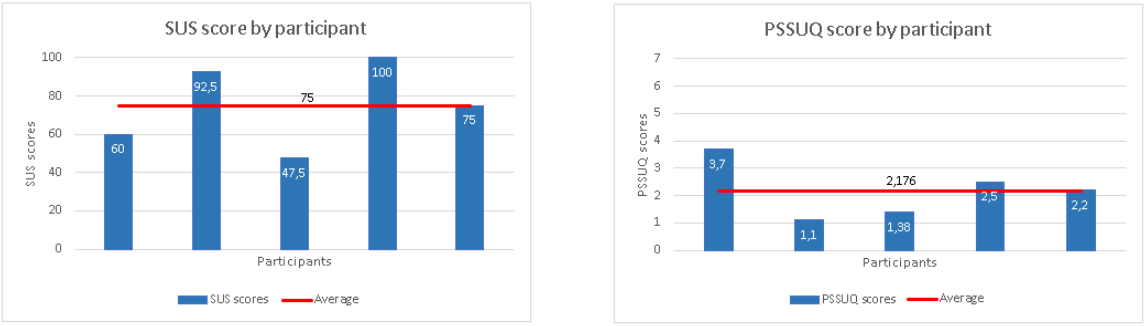


Figure 4.11: SUS and PSSUQ scores, by participant (Third Iteration).

- At the time of searching for a specific technique, the participants exhibited a marked difficulty in accomplishing that, since the technique's navigation bar had no textual description to indicate to which one each icon corresponded to. In addition, it was verified that the color of the navigation bar made it difficult for the participants to perceive its function, assuming that it was a non-constituent component of the application.
- At the moment prior to the execution of a technique, the participants showed some difficulty in perceiving the guide as a slideshow, perceiving it instead as a static image with only one guiding step.
- In the Diaphragmatic Breathing technique, as it started as soon as it was clicked, it was suggested that the system should make a countdown so that the participants could prepare themselves.
- In the course of the techniques, it was verified that the screen blocked after some time of being unused, which had to be changed to guarantee that this would not happen during their execution.
- Finally, at the time of log out, a participant exhibited some difficulty in performing that task, since he expected the log out button to be in his user profile area. Additionally, it was suggested that a log out confirmation message should be prompted before doing so.

Despite the difficulties that the participants were faced with during the execution of the proposed tasks, 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, as further evidenced by a low score obtained from one of the participants (Figure 4.11).

Taking into account the considerations that resulted from this prototype's evaluation, the development of the third prototype ensued. This time, the focus was on the development of a version with a complete implementation of its techniques, and with a higher level of usability, not only to validate the application but also to verify to what extent anxiety management improvements could be attained.

4.5 Fourth Iteration: Development of the Current Application Version

This final iteration concerns the development of a new prototype, considering the difficulties experienced by the participants in the last evaluation. In addition to the implementation

changes, a new usability assessment was also elaborated, using the same evaluation tools, to verify the impact of the changes in the application's usability levels.

4.5.1 Prototype Development

Starting from the list of suggestions and observed difficulties of the last prototype's usability evaluation, some changes and functional additions were deemed necessary. These considerations would potentially result in a higher level of system usability, and in a prototype deemed adequate to undergo evaluations concerning its ability to help users manage their anxiety levels. In this regard, this prototype included the following changes:

- **User's profile**

  Whenever users intended to make changes to their user profile, they often mistaken the place where the data was presented with the place where they could do so. This was due to the fact that their data was presented in a gray rectangle, which led them to believe that it was the appropriate place to change it, when it was actually not. As such, a padlock icon was added to those rectangles in order to give the impression that their data could not be edited at that place, forcing the users to go to the appropriate one. Another change that was made, was the removal of the data updating tab from the ScrollView, making it easier for users to turn their changes permanent and not mistake the place responsible for that. Finally, as a last consideration regarding the user's profile area, its icon was, as well, added to the initial menu, facilitating, this way, its access to the users. All these mentioned changes are depicted in Figure 4.12.
- **Technique's menu navigation**

  Another verified concern was the users' difficulty in interacting with the technique's main menu, where many of them did not even realize the existence of the navigation bar that was used for that purpose. In addition to those who did not notice the navigation bar, the ones who did, could not make an association between the icons and the existing techniques. To tackle both of these issues, the color of the navigation bar was changed, and a textual description was added to its icons, turning it more visible, and allowing the users to directly associate the icons with their corresponding techniques. These changes can be verified in Figure 4.13.
- **Technique's guide slideshow**

  Regarding the difficulty that the users showed in perceiving the guide as being presented in the form of a slideshow, two arrows were added, allowing the presentation to be navigated in an alternative way, and be perceived as the way it should. This can be observed in Figure 4.14.
- **Diaphragmatic Breathing technique's countdown**

  Since the Diaphragmatic Breathing exercise started as soon as it was selected, the users had no chance of making preparations for its execution. As such, a small countdown was introduced so that they could properly prepare themselves before its initiation. A practical example can be seen at Figure 4.15.

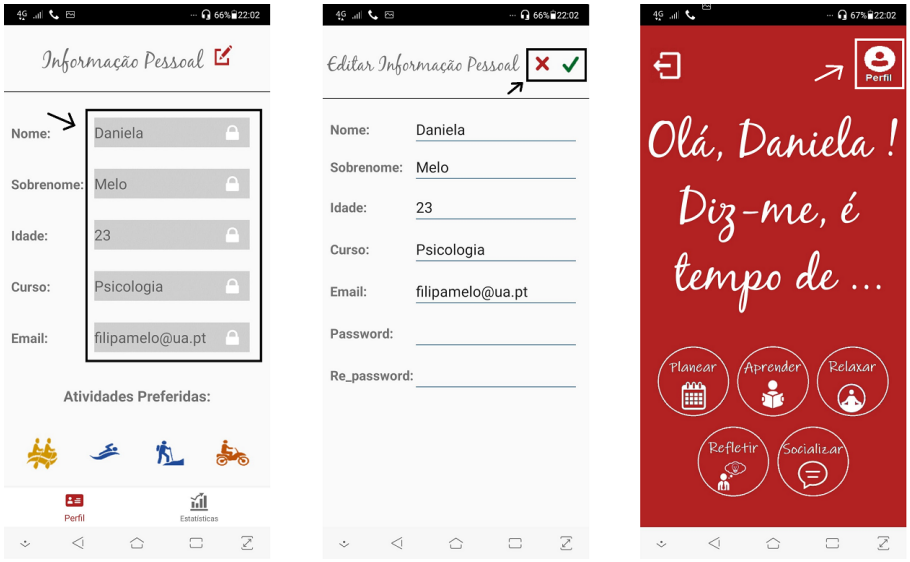


Figure 4.12: User's profile information.

Figure 4.13: Techniques' textual descriptions. A short description was added to each technique's icon so that they could be more easily identified.

- **Logout confirmation**

  In an attempt of preventing potential errors, it was also considered the presentation of a dialog box, with the purpose of confirming if the users really wanted to log out of the application (Figure 4.16).

After implementing all the considered aspects, the development of the third prototype was concluded. It was then time to, once again, make an usability assessment to verify the impact of the newly added features and improvements.

Figure 4.14: Guide's slideshow. Two arrows were added to the slideshow so that it could be perceived as the way it should, allowing the users to gather knowledge regarding the technique's execution.

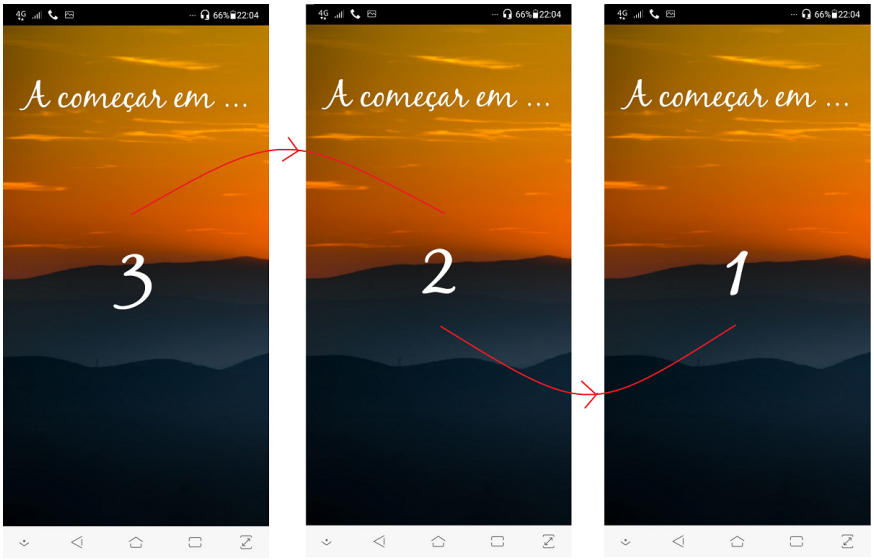


Figure 4.15: Countdown timer. Introduction of a small countdown so that users could prepare themselves before the initiation of the Diaphragmatic Breathing technique.

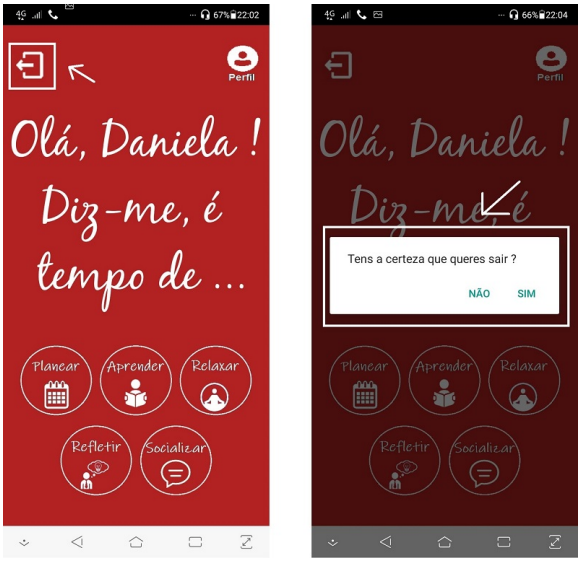


Figure 4.16: Logout confirmation. A logout confirmation message to prevent potential miss clicking errors.

4.5.2 Usability Evaluation

To verify the system's usability after the implementation of the previously mentioned aspects both, the same tasks for the participants to perform, and evaluation tools, were considered. For this evaluation, five new participants were inquired, being three females and two males, all aged between 21-26 years old, and all being Computer Science Engineering students. After the assessment's conclusion, the results were then gathered and organized in a summarized way, as presented in Table 4.2. As it is possible to observe, the participants did not have any problems in accomplishing the tasks that were proposed, which indicates an improvement from the previous evaluation.

In order to understand the impact of the changes on the system's usability, the same evaluation tools were considered. This time, values of 90.5 and 1.608 were, respectively, obtained from the SUS and PSSUQ scales, which demonstrates a notorious improvement compared to the values of 75 and 2.176 from the last iteration's usability evaluation. It 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. These mentioned results, regarding the SUS and PSSUQ scale scores, are depicted in Figure 4.17.

With the achievement of these results, the development of the third prototype was concluded, being characterized as having a good level of usability, and of being complete enough for undergoing first tests with users in stressful situations.

Tasks	Success/Unsuccess	Time in Seconds (Average)	Errors (Average)	Unforeseen Events
Register in the application.	5/0	33.2s	0	-
Log in to the app.	5/0	3.7s	0	-
Edit and complete your profile.	5/0	28.3s	0	-
Get more information about the Muscle Relaxation Technique.	5/0	12.4s	0	-
Setup the Diaphragmatic Breathing Technique for a duration of 7 minutes.	5/0	7.3s	0	-
Select the mute option in the Diaphragmatic Breathing Technique menu.	5/0	2.4s	0	-
Perform the Technique for approximately 1 minute.	5/0	-	0	-
Return to the menu of the Diaphragmatic Breathing Technique and perform it with sound.	5/0	6.7s	0	-
Perform the Muscle Relaxation Technique by contracting and relaxing one of the indicated muscle groups.	5/0	-	0	-
Log out of the application.	5/0	6.5s	0	-

Table 4.2: Observational results table (Fourth Iteration).

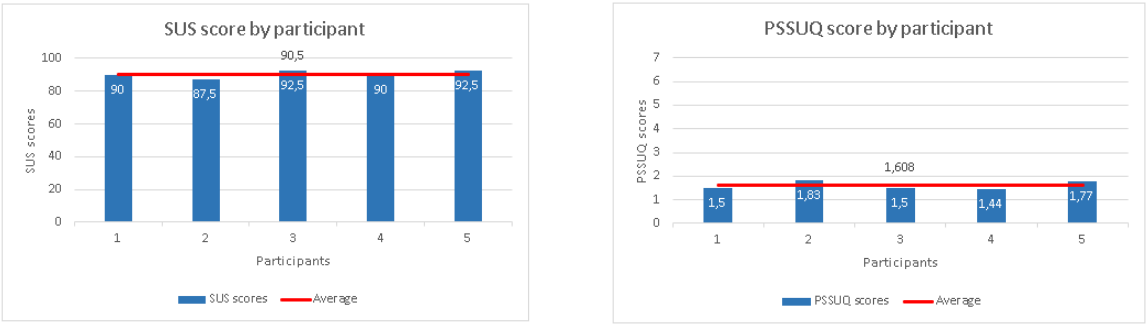


Figure 4.17: SUS and PSSUQ scores, by participant (Fourth Iteration).

4.6 Application Current State

With the considered iterative process for the development of the proposed system, previously described, it was possible to obtain a prototype deemed adequate to undergo a more elaborate test. Furthermore, through the realization of the considered evaluation scales, it was also possible to verify that this version provides its users with pleasant usage experiences. As such, in what follows, we provide an overall summary of the currently supported set of features.

Initially, for the user to be able to access the various available features of the application, it is required that he registers himself on the platform, being his details kept safe in a remote service, which allows him to use the application in whichever device he wants to. After signing in, the user is presented with both, a welcome message that is adapted to his username, and the available options that represent the different system's sections: "Relax", "Plan", "Learn", "Think", and "Socialize". It is important to note that this way of presenting the user with the different options derives from the fact that we wanted to put an emphasis on addressing his motivations. So, instead of presenting him an exhaustive list of the available sections

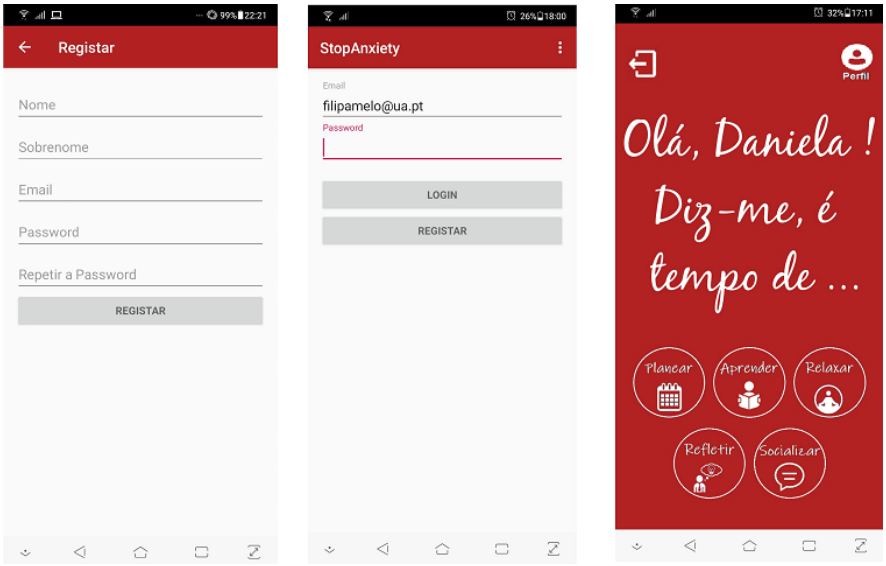


Figure 4.18: Required steps for the initial login, and the home screen from where the main features can be accessed.

of the application, we directly ask him which of his basic needs he wants to see satisfied. Depicted in Figure 4.18 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 Muscle Relaxation. After selecting one of 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 progression, the system keeps the user updated with information, regarding the steps that he needs 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 either 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 (Figure 4.20). However, in the Mindfulness technique, where the instructions are only voice-guided, it was considered the display of a calm nature video in which the practitioners can hear its serene sounds, and visualize its relaxing environment (Figure 4.19). Additionally, with the intent of reducing the videos' storage space, the most similar frames in the shortest time possible were considered, allowing a loop creation that makes it seem as if the video is continuous.

All in all, for this section, three techniques were considered for development, all of which scientifically proven effective in helping its practitioners in managing and reducing their own anxiety levels. In Figure 4.21 are depicted the sub-menus that are associated with the main techniques, and their corresponding, inherent, variants. In an attempt of describing both, the considered techniques, and the benefits of their execution, in a more theoretical approach, a

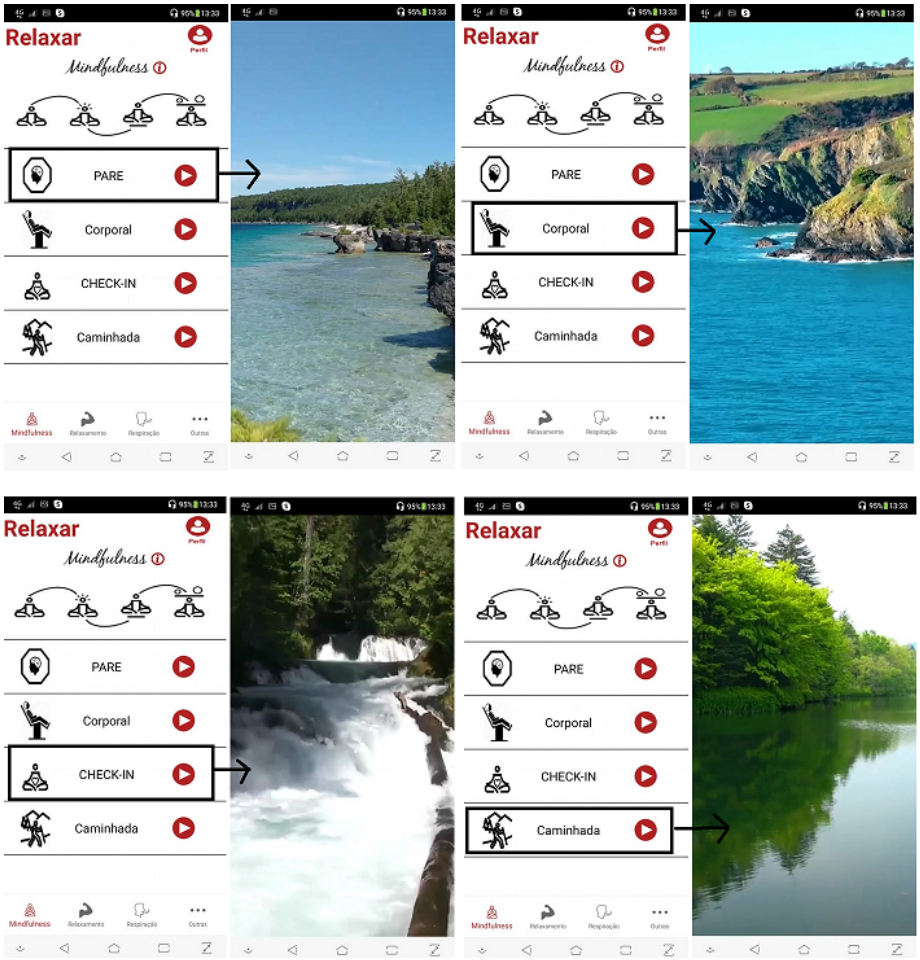


Figure 4.19: Mindfulness technique variants' nature videos.

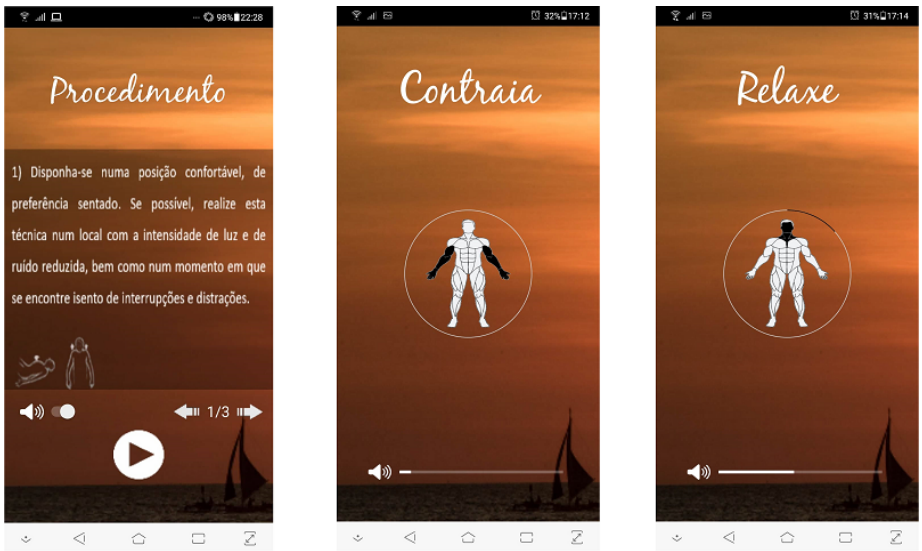


Figure 4.20: Progressive Muscle Relaxation technique. From left to right: the instructions screen, the instruction to contract the muscles in the arms, and the instruction to relax the head and neck muscles.

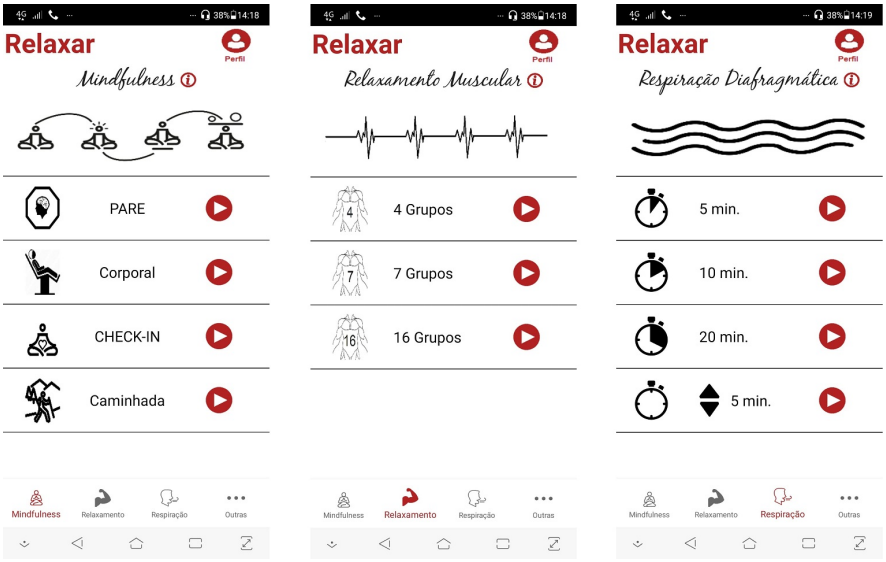


Figure 4.21: Relax section technique's sub-menus. From left to right: the Mindfulness technique's sub-menu that contains its performable variants, the Progressive Muscle Relaxation technique's sub-menu, and the Diaphragmatic Breathing technique's sub-menu.

listing is presented below:

- **Diaphragmatic Breathing**

  The Diaphragmatic Breathing technique consists in performing abdominal inspiration and exhalation cycles, resulting in a great way to reach the entire nervous system, and to bring emotional balance to its practitioners [59].
- **Progressive Muscle Relaxation**

  The Progressive Muscle Relaxation technique consists in the progressive contraction of different muscle groups, keeping the rest of the body relaxed, and, subsequently, releasing the tension. The feeling of the tension relief allows the practitioner to redirect his attention to that pleasant sensation [60].
- **Mindfulness**

  Mindfulness is the ability to be fully present, completely aware of our surroundings, and being capable of not overacting to anxiety-triggering situations. It helps the practitioner in accepting his thoughts and emotions as they are, and not getting influenced by the negative valence that may be associated with them [61].

Given the inherent objectives of the realization of this proof-of-concept, the other sections were considered for future iterations, since the main focus of this work was the development of a prototype deemed adequate to undergo first tests regarding its efficacy in reducing and managing its users' anxiety levels.

4.7 Discussion and Conclusions

This chapter details the different iterations of the design and development of an anxiety management system. In line with has been said, a proof-of-concept application was developed,

adopting an iterative UCD approach, which sought to ensure that the resulting system met the goals and needs of the target users. So far, four design and development iterations have occurred, which resulted in a prototype deemed adequate to undergo first tests concerning its ability to actually help manage anxiety. This prototype incorporates several evidence-based techniques, which are proven to be effective in helping its practitioners in reducing their anxiety levels. Additionally, and all things considered, an experimental protocol is currently being designed, with the purpose of assessing the actual impact of the anxiety management techniques, that are provided by the proposed system, in tackling anxiety.

CHAPTER 5

Affective Modality

Affective Computing is a field that has been vastly explored, and that has been continuously growing, due to how important it is in the development of systems that adapt themselves to whichever human affects that are successfully recognized and interpreted. Being the focus of this work the development of an application for anxiety management, it made all the sense to integrate an emotional extraction tool that would allow it to gather knowledge regarding its users' emotions. Such information would allow the application to adapt itself, and its proposed treatments, offering, this way, a unique and personalized experience to its users. Initially, in this chapter, a brief introduction to the modality's overall vision is made, followed by a description of its inherent architecture. As the chapter's conclusion, it is mentioned how easily integrated this tool can be in the developed application's context, being this process fully described.
At the time of preparing this document, part of the work described in this chapter had already been accepted for presentation in an international conference:

- *David Ferreira, Nuno Almeida, Susana Brás, Sandra C. Soares, António Teixeira, Samuel Silva, "Enabling Multimodal Emotionally-Aware Ecosystems through a W3C-aligned Generic Interaction Modality", Proc. MobiHealth 2019 – 8th EAI International Conference on Wireless Mobile Communication and Healthcare, Dublin, Ireland, November 2019;*

5.1 Generic Affective Modality Conceptualization

In a first stage, a conceptual vision is presented on how Affective Computing would be deployed (and useful) in the diversity of scenarios where interaction is, nowadays, a possibility and a necessity, extending, as well, the ideas that were previously presented in [19].

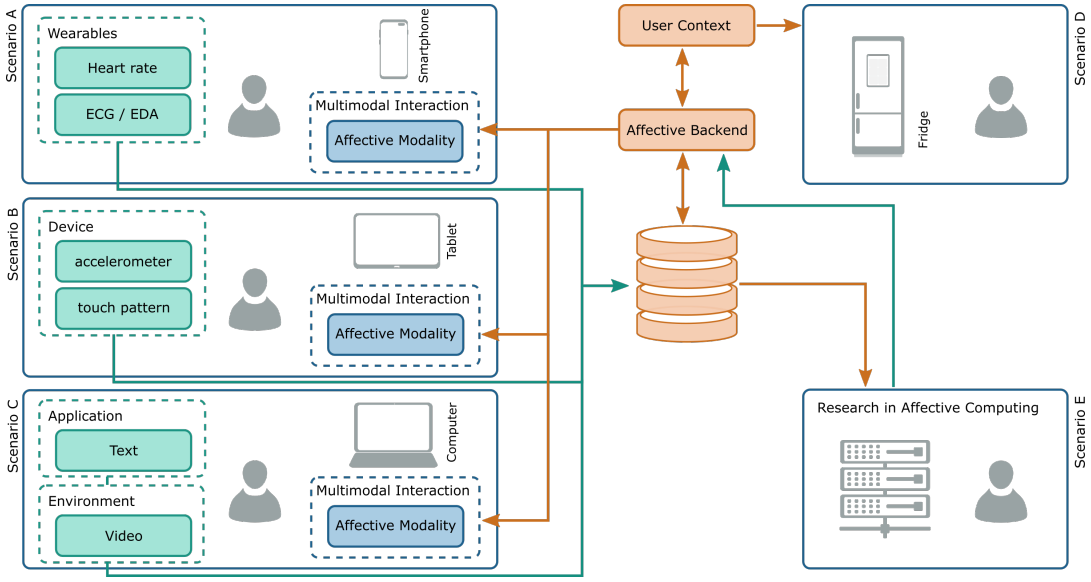


Figure 5.1: Overview of the deployment of emotionally-aware applications in diverse scenarios. The sensing data, and the affective computing logic are decoupled from the interactive systems, being an affective generic modality providing affective inputs to the various interactive contexts.

5.1.1 Conceptual Vision on Affective Computing in a Diverse Multimodal Interactive Ecosystem

Figure 5.1 depicts a set of illustrative scenarios where affective interaction and affective contexts are important features. One of the distinguishing marks of this illustrated vision is the fact that the data used for affective state extraction can be obtained from a wide range of sensors, which may eventually be completely decoupled from the applications. Scenarios A, B, and C depict this diversity, with the sensing being performed at different levels, and not only using wearables or the sensors in the user's device. For instance, a sensor in the environment, such as a surveillance camera, can capture facial expressions that might be used to compute the user's affective state. If the user is, for example, moving around a building, taking, at each time, different devices with him, the interactive ecosystem should be able to make the most out of the available sensing data to adapt itself to the obtained affective information (Scenario C).

Another important aspect to retain is that the interactive systems do not need to have direct access to the sensing data but only to the extracted affective information, enabling a higher degree of data privacy. For instance, if the data used to compute the affective state comes from Electrocardiogram (ECG) data, no application will ever have access to it, but only to the extracted affective information (Scenario A); or an application that is indirectly obtaining affective states, derived from locally acquired accelerometer data, will never have access to it or know where it came from (Scenario B).

Scenario D represents the cases where the system does not explicitly receive an affective input from the Affective Modality. Instead, it can access the available affective information in the user's context, which can be populated through the features that are available in the

affective backend. The main difference is that the information regarding the user's context is not necessarily instantaneous. For example, it can be an overall mood simplified from affective data for a whole day, e.g., of a smart fridge to the user's mood, in that day.

Additionally, Scenario E depicts the Affective Computing research environment. Naturally, it does not entail any interaction. Instead, it provides the means for the researchers to rapidly access relevant data and deploy (improvements of) their methods into interactive ecosystems. This entails that the Affective Backend should be able to integrate novel methods in a way that is transparent for the remaining modules.

5.1.2 Modality's Requirements

Considering a first exploratory work, presenting a first proof-of-concept Affective Modality [19], and the extended context and vision presented in the previous section, a set of requirements was established that, adding to the features already considered for the first version of the modality, should be central in this novel iteration, namely:

- **Cleaner integration with mobile platforms** — The first version of the Affective Modality did not fully respect the W3C standards for Multimodal Interaction, particularly, in how the communication between the modality and the remaining modules of the architecture was performed, with some of the communication logic being tightly coupled with the application's core. Thus, to fully abide to the W3C standard, the new modality should only communicate with the Interaction Manager by resorting to MMI Lifecycle Events. Such consideration would allow the modality to be fully decoupled from the mobile systems, facilitating its integration in a wider range of scenarios;
- **Multiuser support** — To bring the Affective Modality closer to real-world scenarios, one needs to consider that multiple users may be using systems in a simultaneously way, being necessary to ensure that the modality, and its backend, can properly manage their different requests. This requires proper mechanisms for user identification, enabling the backend to know which data might be available for a particular user and where it is authorized to send it.
- **Data storage, and processing of sensing data** — Previously, a Firebase data storage was considered for collecting the sensing data to be processed for affective information extraction. While being a reasonable approach, for demonstration purposes, it raises several scalability and versatility concerns, considering the actual envisaged extended scenario. Therefore, a novel method should be devised to properly deal with the amount and transient nature of the arriving data and its subsequent processing;
- **Affective fusion** — Considering that multiple streams of sensing data can be simultaneously available for each user, that means an equal number of possibilities to extract affective states. Therefore, at a particular time, multiple affective states may be available, and it is important to determine how they are considered to provide a final decision. As such, the novel iteration of the Affective Modality should be able to further allow affective fusion, i.e., how multiple affective states, if available, can be used together;

5.2 Generic Affective Modality's Development

In light of the presented conceptual vision, a generic Affective Modality was designed and developed, improving earlier work, and adopting the features and standards of the AM4I framework [48].

5.2.1 Modality's Architecture and Implementation

Since the proposed anxiety management system was developed considering a multimodal interaction architecture, it was necessary to ensure that the Affective Modality would also be developed adopting such a vision. This consideration allowed the modality to come off-the-shelf and be deployed with little to no effort to configure.

Regarding the development of the Affective Modality, three main modules (stream data processor, hub fusion, modality controller) were deemed relevant for it to properly serve its purpose, being an overview depicted in Figure 5.2. Their main characteristics and roles are as follows:

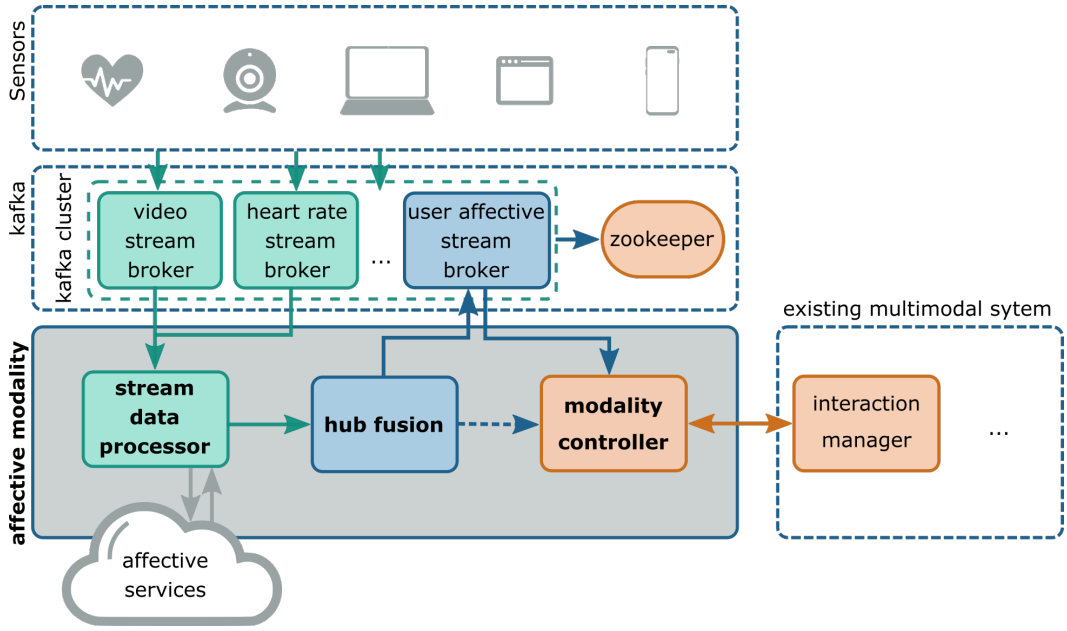


Figure 5.2: Affective Modality's architecture and supporting modules.

- The **modality controller** is responsible for creating a session of data stream consumption whenever a client connects to it. It is responsible for beginning the stream consumption session, and for managing the communication with the Interaction Manager, for instance, to convey changes of the user's affective state.
- The **stream data processor** is a module that runs in the backend, and which is bound to a specific client's session, waiting for incoming streams of data that are relevant for that specific user. When a data stream is successfully consumed, it is then analyzed to determine its data type, either it being GPS, video, audio, image, or other. With both the data type, and the content in its possession, the module looks for services that can

process that type of data (whether local or external) to successfully identify the user's emotional state and further relay it to the **hub fusion** module.

- The **hub fusion** module's purpose is to fuse all the events and emotions that arrive from the **stream data processor**. It tries to combine multiple affective state inputs, which result from the possibility of multiple streams of data being available for the same user, within specific time-windows, resulting in an emotion that characterizes the current emotional state of the user.

5.2.2 Implementation

Although the mechanism to communicate the data streams from the sensors/devices is not part of the Affective Modality, it is important to note how it was implemented. For that, a distributed streaming platform, Apache Kafka[1], was considered to handle all the data streams derived from the available sensors.

These streams are subscribed by the Affective Modality, in the **stream data process**, which then identifies their types and further uses some supported **affective service**, such as Affectiva[2] or Kairos[3], to extract affective information. The **affective services** are a collection of computational methods, which either run locally or remotely, to support the extraction of affective information. The output of this module is delivered to the **hub fusion**, which then merges the information from different sources, and, at this stage, adopts an unsophisticated approach to choose the affective information with the highest confidence level.

After merging the available data, and determining the affective state with the highest confidence level, the **hub fusion** then publishes it in a new stream, so that it can be available for consumption in other places, such as in the **modality controller** which it effectively does. This module then interprets the stream's semantics, and, if a new affective state is detected for that specific user, an MMI life cycle event, containing that data, is generated and sent to the Interaction Manager. After sending the event, all the applications that are part of the multimodal ecosystem, and which are interested in obtaining the affective state of the user to which it belongs, can consume the message so that they can adapt to the detected emotional state.

5.2.3 Integration in the applications' context

The versatility and decoupled nature of the used multimodal architecture enabled the Affective Modality to be easily integrated with the multimodal framework. Whenever the Affective Modality detects a change in the user's affective state, it sends a new event, containing that information, to the Interaction Manager. After the event is sent, it is the responsibility of the Interaction Manager to deliver it to any interested application, that is currently running, and in which the user that the event belongs to is currently logged.

The applications that are present in the multimodal ecosystem will continuously receive the new events that are generated by the Affective Modality, which contain the affective states

[1] Apache Kafka: `https://kafka.apache.org/`
[2] https://www.affectiva.com/
[3] https://www.kairos.com/

of its users, to adapt accordingly. It is important to mention that, for the applications to be able to deploy the Affective Modality and subsequently receive their users' emotional updates, they need to implement and be able to communicate with the Interaction Manager.

5.3 Modality's Integration in the Proposed Anxiety Management System

Considering how important and beneficial emotionally-aware systems can be, the proposed Affective Modality, which resulted from an extension of a previously elaborated work, was integrated into the developed anxiety management system. Such integration enables the system to be aware of its users' emotional states, and may further allow it to adapt itself, and its proposed treatments, accordingly, providing its users with unique and personalized experiences.

A practical example of the integration of the Affective Modality in the developed system is illustrated in Figure 5.3. For the sake of simplicity, the webcam of the user's laptop is active and forwarding the video feed to his corresponding Kafka topic. The application, as soon as the user logs in, informs the modality that it has an interest in being updated regarding possible changes in its user's emotional state. When the video data reaches the user's topic, the Affective Modality backend processes it using one of the available affective services, being FaceApi considered in the illustrated example. As soon as the user's emotional state is identified, it is then redirected to the developed application so that it can react accordingly.

One of the greatest advantages of this approach is that, by integrating the developed modality, the app developers simply need to declare that they want to know the users' affective states and subsequently deal with the semantic contents of the events that reach their system. This way, most of the complexity that is inherent to emotional extraction is transparently handled by remote services or toolkits, allowing the developers to focus on the system's development.

Depicted in Figure 5.4 is a concrete example in which a state of sadness is detected in the current logged in user, being suggested that he performs a relaxation technique to possibly reduce the impact of this emotional state. Although, in this example, the detected emotion corresponds to the sadness one, the system can still receive feedback that may be representative of several other emotions, namely: anger, contempt, disgust, fear, happiness, neutral, and surprise. It is further important to mention that the illustrated example was only considered for demonstration purposes, since it is never a good practice to tell the users that they are, in fact, sad.

Another practical example in which the integration of this modality, after being extended with the appropriate affective computing methods, can be highly useful to the system that integrates it, is the ability to perceive the emotional state of the user while he performs the proposed techniques, enabling the system, at the end of their execution, to have a notion of how their realization made him subsequently feel (Figure 5.5). This would not only make it possible to verify the plausibility of each technique's proposal for future related occasions but also the impact that their execution had in improving the user's emotional state.

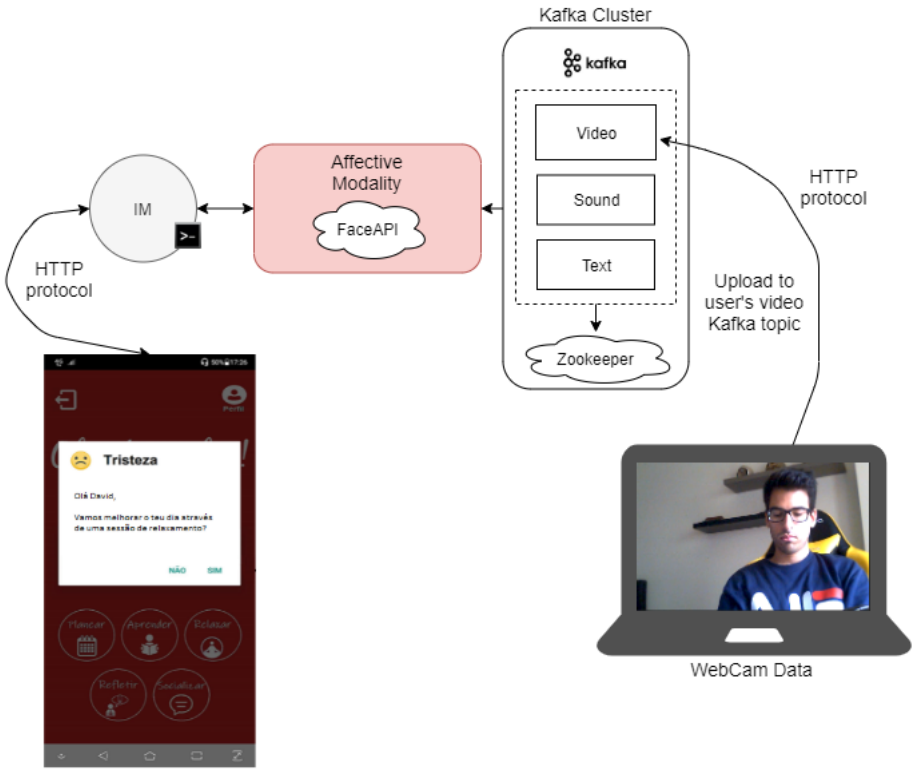


Figure 5.3: Practical example of the Modality's Integration. A laptop camera captures the user's face, and that video data serves as a source for the Affective Modality to compute its associated affective state, subsequently notifying the application, on the user's smartphone, about that emotional update.

Although these two concrete examples were considered, regarding the integration of the Affective Modality into the proposed anxiety management system, it is essential to note as well that, since the users' emotional updates are continually arriving at the system, it is possible to adapt it to any circumstances, and not just the two that were mentioned. In conclusion, this integration allows for a multitude of possible ways to provide users with adaptable tools to help them acquire the health benefits they need.

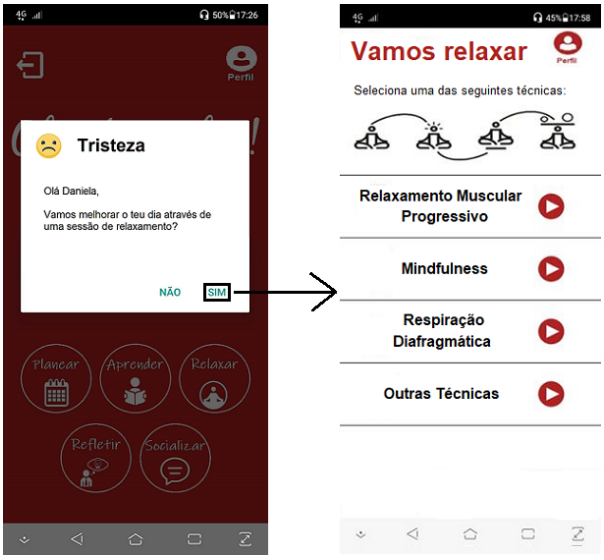


Figure 5.4: Technique's suggestion after a sadness emotion update is received. A state of sadness is detected in the current logged in user, being suggested that he performs a relaxation technique to possibly reduce the impact of this emotional state.

Figure 5.5: Technique's conclusion survey, with a process running in background that is responsible for verifying the predominant user's emotional state throughout the technique's execution.

5.4 Discussion and Conclusions

This chapter evolves early work in proposing a conceptual vision for the deployment of multimodal emotionally-aware ecosystems, and showcases an improved version of a key component in this vision, a generic Affective Modality. This modality is proposed in the scope of a multimodal interactive framework, the AM4I, enabling any system that adopts it to have off-the-shelf support for affective inputs. In this regard, the full adoption of the standards proposed by the W3C also enabled a fully decoupled communication between mobile applications and the proposed modality, which was not possible in the first presented proof-of-

concept [19]. Additionally, this vision advances how the research in Affective Computing can more rapidly integrate with real scenarios, and the proposal of a sensing repository based on Kafka should enable the consideration of technologies, such as Kafka Streams, to support the development of affective methods, thus facilitating their faster integration with the Affective Modality.

CHAPTER 6

Conclusions

In this final chapter, an overview of the developed work is presented and discussed. In addition, future considerations to further extend and improve it are suggested.

6.1 Overall Analysis

Firstly, since the development of the application was in a multidisciplinary context, in collaboration with Psychology professionals, there was a need to consider interdisciplinary methodologies that allowed a more efficient and effective teamwork. As such, 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 for the correct development of the anxiety management system.

With the conclusion of the requirements elicitation phase, the focus was the development of a proof-of-concept application, adopting an iterative UCD approach to ensure that the resulting system would meet the goals and needs of its potential users. The resulting application incorporates several techniques, such as Mindfulness, Diaphragmatic Breathing, and Progressive Muscle Relaxation, which are scientifically proven as being capable of helping its practitioners in managing and reducing their anxiety levels. It was possible to describe the whole system's development life cycle by detailing each of its development and subsequent evaluation stages, being that, from such evaluations, good levels of usability resulted.

Lastly, a generic Affective Modality was developed that allows the applications that integrate it to have data concerning its users' emotional states. For that, and starting from a first instance, already developed by [19], some improvements were made, reaching a point where we now have, at our disposal, a generic Affective Modality that is capable of processing several data streams, in real-time, and extract the current emotional states of the users they correspondingly belong to. The modality's major benefit is that it allows an easy integration of an emotion extraction tool in the context of mHealth development, enabling the applications that integrate it to adapt themselves to whichever human affects they receive as input.

Overall, the work presented in this document has successfully reached the objectives established, at the beginning, and the scientific relevance of the presented contributions is made evident by the articles already accepted for publication. Additionally, the methodology and adopted architecture enable that, at its current stage, the work carried out can serve as grounds for a continued effort in understanding and evolving anxiety management through mHealth approaches.

6.2 Future Work

While the proposed objectives have all been attained, there are still several aspects that can be improved and explored, not only in the proposed system, considering the requirements that can still be addressed, but in the developed modality as well. As such, some consideration are now suggested to further extend and improve the developed work in future studies.

Psychoeducation consists in the provision of systematic, structured, and didactic information about mental disorders and its respective treatments, which also includes other considerations that empower both the subjects and their relatives. Additionally, psychoeducation also augments the management capacity of the patients' conditions, consequently improving their current symptomatology and prognosis. With this said, it would be highly beneficial to the proposed system if it would be extended with a psychoeducation area, allowing its users to learn about the main symptoms of the existing disorders, and teaching them how to deal with them at an early stage to possibly prevent them from transposing into real disorders.

Another important component that should be implemented in the proposed system is a time management feature, since time management difficulties were identified in the elaborated focus group sessions as being one of the main promoters of anxiety in both students and teachers. From these sessions, it was clear that they needed a tool that would propose schedules adapted to their biological rhythms, as well as their daily tasks and favorite leisure activities, providing them with a schedule that would allow them to enjoy their daily life, and not stress with their possible lack of time.

Regarding the Affective Modality, the work developed, so far, only allows it to extract emotions from data streams that contain image data, even though it can, in fact, receive the ones that correspond to other types of data as well, such as audio, video, text, and others. Therefore, it is suggested, in future studies, that the processing capacity of this modality is extended, so that it not only receives the data that arrives from the diverse data stream types but also process them, reusing all the extracted data for accurately assessing the user's emotional state.

After processing the data, the Affective Modality then identifies the emotional state of the user it correspondingly belongs to, with this process taking place at the Fusion Engine. So far, since image data is the only considered data type in which emotions can be extracted, the resulting emotion is simply redirected to the applications that consume it. However, the Fusion Engine can be extended so that it can have the capacity to infer the emotional state of its users by taking into account multiple received inputs, that is, not only from emotions

that are extracted from images but from other data types as well. In order for this to happen, it is required that the Fusion Engine is capable of counterbalancing all the information that is extracted from the different data types, since it is possible, for example, that the user's textual data associates him with an emotion of sadness, the image data associates him with an emotion of joy, and the source of audio associates him with an emotion of sadness as well, thus, making it difficult to properly identify the emotion that truly represents the user's current emotional state. Therefore, in order for this tool to be able to counterbalance and identify the appropriate emotional state of the user, with all the received information, a scientific literature analysis of this area is truly required, to properly confirm the validation of each emotion source and its relationship with the real emotional state of the users they correspondingly belong to. As such, it is suggested that, in the future, this modality is further improved, to turn it into an even better tool that easily allows applications to have access to its users' emotional states.

A final consideration that would be highly beneficial is the development of a context modality, capable of interpreting the contextual and environmental conditions in which the users are present to allow the interested systems in better adapting themselves to it. An illustrative example would be a case where the system realizes that the user has recurrent higher levels of anxiety when it is in a particular public establishment, and adapt its guidelines and proposed techniques in an attempt of helping him out. In fact, this modality would be highly valuable, since it would allow the interested systems in adapting themselves to the contexts where their users are at, thus, providing them with individual and personalized experiences.

References

[1] H. Haller, H. Cramer, R. Lauche, F. Gass, and G. J. Dobos, "The prevalence and burden of subthreshold generalized anxiety disorder: A systematic review", *BMC Psychiatry*, vol. 14, no. 1, p. 128, 2014.

[2] H. Wittchen and F. Jacobi, "Size and burden of mental disorders in europe: A critical review and appraisal of 27 studies", *European Neuropsychopharmacology*, vol. 15, no. 4, pp. 357–376, 2005.

[3] T. Michael, U. Zetsche, and J. Margraf, "Epidemiology of anxiety disorders", *Psychiatry*, vol. 6, no. 4, pp. 136–142, 2007.

[4] R. C. Kessler, S. Aguilar-Gaxiola, J. Alonso, S. Chatterji, S. Lee, J. Ormel, T. B. Üstün, and P. S. Wang, "The global burden of mental disorders: An update from the who world mental health (WMH) surveys", *Epidemiology and Psychiatric Sciences*, vol. 18, no. 1, pp. 23–33, 2009.

[5] D. Chisholm, K. Sweeny, P. Sheehan, B. Rasmussen, F. Smit, P. Cuijpers, and S. Saxena, "Scaling-up treatment of depression and anxiety: A global return on investment analysis", *The Lancet Psychiatry*, vol. 3, no. 5, pp. 415–424, 2016.

[6] S. Mack, F. Jacobi, A. Gerschler, J. Strehle, M. Höfler, M. A. Busch, U. E. Maske, U. Hapke, I. Seiffert, W. Gaebel, *et al.*, "Self-reported utilization of mental health services in the adult german population–evidence for unmet needs? Results of the DEGS1-Mental Health Module (DEGS1-MH)", *International Journal of Methods in Psychiatric Research*, vol. 23, no. 3, pp. 289–303, 2014.

[7] J. Firth, J. Torous, R. Carney, J. Newby, T. D. Cosco, H. Christensen, and J. Sarris, "Digital technologies in the treatment of anxiety: Recent innovations and future directions", *Current Psychiatry Reports*, vol. 20, no. 6, p. 44, 2018.

[8] D. Bakker, N. Kazantzis, D. Rickwood, and N. Rickard, "Mental health smartphone apps: Review and evidence-based recommendations for future developments", *JMIR Mental Health*, vol. 3, no. 1, 2016.

[9] J. Torous, J. Firth, K. Huckvale, M. E. Larsen, T. D. Cosco, R. Carney, S. Chan, A. Pratap, P. Yellowlees, T. Wykes, *et al.*, "The emerging imperative for a consensus approach toward the rating and clinical recommendation of mental health apps", *The Journal of Nervous and Mental Disease*, vol. 206, no. 8, pp. 662–666, 2018.

[10] C. Morgan, E. Mason, J. M. Newby, A. E. Mahoney, M. J. Hobbs, J. McAloon, and G. Andrews, "The effectiveness of unguided internet cognitive behavioural therapy for mixed anxiety and depression", *Internet Interventions*, vol. 10, pp. 47–53, 2017.

[11] M. Neary and S. M. Schueller, "State of the field of mental health apps", *Cognitive and Behavioral Practice*, 2018.

[12] U. Sarkar, G. I. Gourley, C. R. Lyles, L. Tieu, C. Clarity, L. Newmark, K. Singh, and D. W. Bates, "Usability of commercially available mobile applications for diverse patients", *Journal of General Internal Medicine*, vol. 31, no. 12, pp. 1417–1426, 2016.

[13] J. Armontrout, J. Torous, M. Fisher, E. Drogin, and T. Gutheil, "Mobile mental health: Navigating new rules and regulations for digital tools", *Current Psychiatry Reports*, vol. 18, no. 10, p. 91, 2016.

[14] A. Kappas, "Smile when you read this, whether you like it or not: Conceptual challenges to affect detection", *IEEE Transactions on Affective Computing*, vol. 1, no. 1, pp. 38–41, 2010.

[15] OneMind. (2018). App guide, [Online]. Available: `https://psyberguide.org/apps/` (visited on 04/25/2019).

[16] D. Bakker and N. Rickard, "Engagement in mobile phone app for self-monitoring of emotional wellbeing predicts changes in mental health: MoodPrism", *Journal of Affective Disorders*, vol. 227, pp. 432–442, 2017.

[17] J. Boettcher, K. Magnusson, A. Marklund, E. Berglund, R. Blomdahl, U. Braun, L. Delin, C. Lundén, K. Sjöblom, D. Sommer, *et al.*, "Adding a smartphone app to internet-based self-help for social anxiety: A randomized controlled trial", *Computers in Human Behavior*, vol. 87, pp. 98–108, 2018.

[18] G. C.-L. Hung, P.-C. Yang, C.-Y. Wang, and J.-H. Chiang, "A smartphone-based personalized activity recommender system for patients with depression", in *Proceedings of the 5th EAI International Conference on Wireless Mobile Communication and Healthcare*, ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 2015, pp. 253–257.

[19] T. Henriques, S. C. Soares, S. Silva, N. Almeida, S. Brás, and A. Teixeira, "Emotionally-aware multimodal interfaces: Preliminary work on a generic affective modality", *DSAI 2018, June 20-–22, 2018, Thessaloniki, Greece*, 2018.

[20] C. Fuentes, V. Herskovic, I. Rodrıguez, C. Gerea, M. Marques, and P. O. Rossel, "A systematic literature review about technologies for self-reporting emotional information", *Journal of Ambient Intelligence and Humanized Computing*, vol. 8, no. 4, pp. 593–606, 2017.

[21] S. Shah, J. N. Teja, and S. Bhattacharya, "Towards affective touch interaction: Predicting mobile user emotion from finger strokes", *Journal of Interaction Science*, vol. 3, no. 1, p. 6, 2015.

[22] B. N. Renn, A. Pratap, D. C. Atkins, S. D. Mooney, and P. A. Areán, "Smartphone-based passive assessment of mobility in depression: Challenges and opportunities", *Mental Health and Physical Activity*, vol. 14, pp. 136–139, 2018.

[23] N. Rickard, H.-A. Arjmand, D. Bakker, and E. Seabrook, "Development of a mobile phone app to support self-monitoring of emotional well-being: A mental health digital innovation", *JMIR Mental Health*, vol. 3, no. 4, e49, 2016.

[24] A. Howells, I. Ivtzan, and F. J. Eiroa-Orosa, "Putting the 'app'in happiness: A randomised controlled trial of a smartphone-based mindfulness intervention to enhance wellbeing", *Journal of Happiness Studies*, vol. 17, no. 1, pp. 163–185, 2016.

[25] M. Fenger, J. Lindschou, C. Gluud, P. Winkel, L. Jørgensen, S. Kruse-Blinkenberg, and M. Lau, "Internet-based self-help therapy with FearFighter™ versus no intervention for anxiety disorders in adults: Study protocol for a randomised controlled trial", *Trials*, vol. 17, no. 1, p. 525, 2016.

[26] B. N. Gaynes, J. DeVeaugh-Geiss, S. Weir, H. Gu, C. MacPherson, H. C. Schulberg, L. Culpepper, and D. R. Rubinow, "Feasibility and diagnostic validity of the M-3 checklist: A brief, self-rated screen for depressive, bipolar, anxiety, and post-traumatic stress disorders in primary care", *The Annals of Family Medicine*, vol. 8, no. 2, pp. 160–169, 2010.

[27] S. A. Loughnan, J. M. Newby, H. Haskelberg, A. Mahoney, N. Kladnitski, J. Smith, E. Black, C. Holt, J. Milgrom, M.-P. Austin, *et al.*, "Internet-based cognitive behavioural therapy (iCBT) for perinatal anxiety and depression versus treatment as usual: Study protocol for two randomised controlled trials", *Trials*, vol. 19, no. 1, p. 56, 2018.

[28] C. Peretz, A. D. Korczyn, E. Shatil, V. Aharonson, S. Birnboim, and N. Giladi, "Computer-based, personalized cognitive training versus classical computer games: A randomized double-blind prospective trial of cognitive stimulation", *Neuroepidemiology*, vol. 36, no. 2, pp. 91–99, 2011.

[29] M. Preiss, E. Shatil, R. Cermakova, D. Cimermannova, and I. Flesher, "Personalized cognitive training in unipolar and bipolar disorder: A study of cognitive functioning", *Frontiers in Human Neuroscience*, vol. 7, p. 108, 2013.

[30] D. Bakker and N. Rickard, "Engagement with a cognitive behavioural therapy mobile phone app predicts changes in mental health and wellbeing: MoodMission", *Australian Psychologist*, vol. 54, no. 4, pp. 245–260, 2019.

[31] T. A. Dennis and L. J. O'Toole, "Mental health on the go: Effects of a gamified attention-bias modification mobile application in trait-anxious adults", *Clinical Psychological Science*, vol. 2, no. 5, pp. 576–590, 2014.

[32] K. K. Fitzpatrick, A. Darcy, and M. Vierhile, "Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): A randomized controlled trial", *JMIR Mental Health*, vol. 4, no. 2, e19, 2017.

[33] D. Bakker, N. Kazantzis, D. Rickwood, and N. Rickard, "A randomized controlled trial of three smartphone apps for enhancing public mental health", *Behaviour Research and Therapy*, vol. 109, pp. 75–83, 2018.

[34] F. Naeem, N. Gire, S. Xiang, M. Yang, Y. Syed, F. Shokraneh, C. Adams, and S. Farooq, "Reporting and understanding the safety and adverse effect profile of mobile apps for psychosocial interventions: An update", *World Journal of Psychiatry*, vol. 6, no. 2, p. 187, 2016.

[35] I. M. Aderka, A. Nickerson, H. J. Bøe, and S. G. Hofmann, "Sudden gains during psychological treatments of anxiety and depression: A meta-analysis.", *Journal of Consulting and Clinical Psychology*, vol. 80, no. 1, p. 93, 2012.

[36] B. Bandelow, S. Michaelis, and D. Wedekind, "Treatment of anxiety disorders", *Dialogues in Clinical Neuroscience*, vol. 19, no. 2, p. 93, 2017.

[37] P. Cuijpers, M. Sijbrandij, S. Koole, M. Huibers, M. Berking, and G. Andersson, "Psychological treatment of generalized anxiety disorder: A meta-analysis", *Clinical Psychology Review*, vol. 34, no. 2, pp. 130–140, 2014.

[38] B. Bandelow, M. Reitt, C. Röver, S. Michaelis, Y. Görlich, and D. Wedekind, "Efficacy of treatments for anxiety disorders: A meta-analysis", *International Clinical Psychopharmacology*, vol. 30, no. 4, pp. 183–192, 2015.

[39] S. Silva, R. Felgueiras, and I. C. Oliveira, "Geriatric Helper: An mHealth application to support comprehensive geriatric assessment", *Sensors (Basel, Switzerland)*, vol. 18, no. 4, 2018.

[40] L. Bondemark and S. Ruf, "Randomized controlled trial: The gold standard or an unobtainable fallacy?", *European Journal of Orthodontics*, vol. 37, no. 5, pp. 457–461, 2015.

[41] S. Silva, S. C. Soares, S. Brás, J. M. Fernandes, M. Coroa, N. Madeira, T. Santos, and P. J. Ferreira, "From the lab into people's lives: Setting a roadmap for mental healthcare assistive technologies derived from psychophysiology", *26th Congress of the European Psyquiatric Association (EPA 2018), 3-6 March 2018 Nice, France*, 2018.

[42] A. Cooper, R. Reimann, D. Cronin, and C. Noessel, *About face: The essentials of interaction design*. John Wiley & Sons, 2014.

[43] S. Oviatt, R. Coulston, and R. Lunsford, "When do we interact multimodally? Cognitive load and multimodal communication patterns", in *Proceedings of the 6th International Conference on Multimodal Interfaces*, ACM, 2004, pp. 129–136.

[44] D. A. Dahl, *Multimodal interaction with W3C standards*. Springer, 2016.

[45] B. Dumas, D. Lalanne, and S. Oviatt, "Multimodal interfaces: A survey of principles, models and frameworks", in *Human machine interaction*, Springer, 2009, pp. 3–26.

[46] M. Serrano, L. Nigay, J.-Y. L. Lawson, A. Ramsay, R. Murray-Smith, and S. Denef, "The openinterface framework: A tool for multimodal interaction", in *Proceeding of the Twenty-sixth Annual CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI '08*, New York, New York, USA: ACM Press, Apr. 2008, p. 3501, ISBN: 978160558012X. DOI: 10.1145/1358628.1358881.

[47] L. Hoste, B. Dumas, and B. Signer, "Mudra: A unified multimodal interaction framework", in *Proceedings of the 13th International Conference on Multimodal Interfaces*, ser. ICMI '11, New York, NY, USA: ACM, 2011, pp. 97–104, ISBN: 978-1-4503-0641-6. DOI: 10.1145/2070481.2070500.

[48] N. Almeida, A. Teixeira, S. Silva, and M. Ketsmur, "The AM4I architecture and framework for multimodal interaction and its application to smart environments", *Sensors*, vol. 19, no. 11, pp. 25–87, 2019.

[49] N. Almeida, S. Silva, A. Teixeira, and D. Vieira, "Multi-device applications using the multimodal architecture", in *Multimodal interaction with W3C standards*, Springer, 2017, pp. 367–383.

[50] N. Almeida, S. Silva, and A. Teixeira, "Design and development of speech interaction: A methodology", in *Proc. HCII*, Springer, 2014, pp. 370–381.

[51] S. Leigh and S. Flatt, "App-based psychological interventions: Friend or foe?", *Evidence-based Mental Health*, ebmental–2015, 2015.

[52] S. Silva and A. Teixeira, "Design and development for individuals with ASD: Fostering multidisciplinary approaches through personas", *Journal of Autism and Developmental Disorders*, vol. 49, no. 5, pp. 2156–2172, 2019.

[53] K. Chen and H. Zhang, "Remote paper prototype testing", in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM, 2015, pp. 77–80.

[54] J. Nielsen, *Heuristic evaluation. Usability inspection methods. Edited by: Nielsen J, Mack RL. 1994.*

[55] A. Bangor, P. T. Kortum, and J. T. Miller, "An empirical evaluation of the system usability scale", *Intl. Journal of Human–Computer Interaction*, vol. 24, no. 6, pp. 574–594, 2008.

[56] A. I. Martins, A. F. Rosa, A. Queirós, A. Silva, and N. P. Rocha, "European portuguese validation of the system usability scale (SUS)", *Procedia Computer Science*, vol. 67, pp. 293–300, 2015.

[57] J. R. Lewis, "Psychometric evaluation of the PSSUQ using data from five years of usability studies", *International Journal of Human-Computer Interaction*, vol. 14, no. 3-4, pp. 463–488, 2002.

[58] A. F. Rosa, A. I. Martins, V. Costa, A. Queirós, A. Silva, and N. P. Rocha, "European portuguese validation of the post-study system usability questionnaire (PSSUQ)", in *2015 10th Iberian Conference on Information Systems and Technologies (CISTI)*, IEEE, 2015, pp. 1–5.

[59] R. Jerath, M. W. Crawford, V. A. Barnes, and K. Harden, "Self-regulation of breathing as a primary treatment for anxiety", *Applied psychophysiology and biofeedback*, vol. 40, no. 2, pp. 107–115, 2015.

[60] J. I. Gallego-Gómez, S. Balanza, J. Leal-Llopis, J. A. Garcıa-Méndez, J. Oliva-Pérez, J. Doménech-Tortosa, M. Gómez-Gallego, A. J. Simonelli-Muñoz, and J. M. Rivera-Caravaca, "Effectiveness of music therapy and progressive muscle relaxation in reducing stress before exams and improving academic performance in nursing students: A randomized trial", *Nurse education today*, vol. 84, p. 104 217, 2020.

[61] J. Vøllestad, M. B. Nielsen, and G. H. Nielsen, "Mindfulness-and acceptance-based interventions for anxiety disorders: A systematic review and meta-analysis", *British journal of clinical psychology*, vol. 51, no. 3, pp. 239–260, 2012.

Appendix A

Cenários de Contexto

Gestão de horário/Gestão de tarefas

RUTE

Na época de exames, a Rute experiencia sintomatologia ansiosa que interfere com a sua capacidade de gestão de tempo, o que, consequentemente, aumenta a sua ansiedade e reduz a qualidade do seu estudo. A Rute já recorreu a diversos sistemas de gestão de tempo, porém nenhum deles se adaptava às suas preferências, nem organizava as suas tarefas no período de tempo pretendido. Ao experimentar um novo sistema de gestão de ansiedade, a Rute verificou que, semanalmente, este sugeria a inserção das suas atividades quotidianas e de lazer, o volume de matéria a estudar e as avaliações a realizar, de modo a que este sistema consiga organizar as tarefas a concretizar nesse período, adaptando aos seus ritmos biológicos e preferências. Deste modo, o sistema disponibiliza diariamente tarefas atingíveis, que facilita a capacidade de gestão de tempo, reduzindo a ansiedade da Rute, pois, assim, conseguia realizar as suas atividades, assim como rentabilizar o estudo, promovendo o seu sucesso académico.

CARLOS

Após a reunião de início de semestre, Carlos, ao deparar-se com a quantidade de trabalho que terá de cumprir no decorrer do próximo mês de aulas, experiencia sintomatologia ansiosa. Embora já tenha recorrido a várias estratégias de organização de tarefas, estas não se evidenciaram eficazes, uma vez que exigiam demasiado de si, resultando no incumprimento das mesmas e, consequentemente, no aumento da ansiedade. Assim sendo, Carlos decidiu recorrer a um sistema de gestão de ansiedade, que permitia a organização das tarefas a concretizar num limite temporal estabelecido, considerando, complementarmente, as suas atividades diárias e de lazer, bem como os seus ritmos biológicos e preferências, inseridas previamente pelo docente. Após o término da reunião, Carlos consulta o que terá de concretizar na hora seguinte, verificando que tinha planeado concluir a explicação dos procedimentos do *paper,* por duas horas. No final das duas horas, o sistema emite um alerta, referindo que já terminou o período dedicado a essa tarefa e que estaria no momento de concretizar a sua caminhada diária. Deste modo, o Carlos, ao verificar que conseguiu cumprir com o planeado para o seu dia, conseguiu sentir que o seu tempo foi rentabilizado ao máximo, permitindo uma redução da sua ansiedade e uma promoção do seu bem estar e qualidade de vida.

Gestão da ansiedade

CARLOS

São 14 horas e 45 minutos. O Carlos, que se encontra no trânsito, como tem agendada uma reunião importantíssima para as 15 horas, começa a reconhecer a presença de vários sintomas caracterizadores de ansiedade. Como o seu *smartphone* se encontrava ligado o sistema multimédia do seu automóvel, decide recorrer ao seu sistema de gestão de ansiedade, de modo a praticar uma técnica de respiração diafragmática, predileta em momentos semelhantes. O sistema disponibiliza uma música relaxante, recordando-o que se deverá ajustar numa posição minimamente confortável, assim como respirar pelo nariz, garantindo que a respiração se realiza ao nível da zona abdominal. Cada ciclo de inspiração e de expiração detém uma duração aproximada de quatro segundos, sendo que o sistema assinala cada momento de inspiração e de expiração, respetivamente. Após 10 minutos da realização desta técnica, o Carlos experiencia uma redução da sintomatologia ansiosa por ele reconhecida, fornecendo-lhe uma maior capacidade para lidar favoravelmente com a reunião que se segue.

RUTE

Faltam 15 minutos para o último exame deste semestre. Atendendo a acumulação do cansaço, da ansiedade e do volume de matéria exigido para este exame, o sistema tem conhecimento de que a Rute se encontra bastante ansiosa e propõe uma técnica de respiração diafragmática, técnica que recorre frequentemente antes de qualquer momento de avaliação. Considerando que a Rute já se encontra próxima da sala de exame, rodeada dos seus colegas, o sistema solicita que a Rute se sente confortavelmente, preparando-a para uma série de ciclos de inspiração e expiração. A fim de facilitar a realização desta técnica, o sistema emite sinais vibratórios, de modo a que Rute os consiga sentir, e compreender, a cada quatro segundos, quando deve de inspirar ou expirar. No final dos ciclos de respiração, a Rute sente-se mais tranquila e confiante para a concretização do exame. Após o término deste momento de avaliação, a aluna verificou que não teve qualquer "branca" no decorrer do mesmo, assim como respondeu completamente a todas as questões.

HENRIQUE

Chegou à altura dos primeiros jantares académicos. Considerando que entrou mais tarde que os restantes elementos da turma, o Henrique sente-se bastante nervoso com a aproximação deste evento social. Enquanto se preparava para o jantar, o sistema obtém informação sobre a presença de sintomatologia ansiosa, o que despoletou um alerta para a sugestão da realização de uma técnica de relaxamento, especificamente a respiração diafragmática. Como foi a primeira vez que o Henrique experimentou esta técnica, e como se encontrava sozinho no quarto, o sistema informou-o que se deveria posicionar de modo confortável e fechar os olhos, se assim se sentisse mais tranquilo. Seguidamente, explica que, para a realização dos ciclos de inspiração e de expiração, o Henrique necessita de respirar, essencialmente pelo nariz, sendo esta respiração efetuada ao nível do abdómen. A fim de verificar a correta aplicação desta técnica, o sistema sugere que coloque uma mão sobre a zona abdominal e a outra sobre o peito. O objetivo consiste em manter imóvel a mão que se encontra no peito, sentindo os movimentos provenientes da respiração apenas na mão que se encontra no abdómen. Iniciam-se os ciclos de inspiração e de expiração, com uma duração de quatro segundos cada, sendo que o sistema de gestão de ansiedade indica os momentos de inspirar e de expirar. Passados 10 minutos da prática contínua destes ciclos, o Henrique começa a sentir-se mais calmo e tranquilo. No momento em que chega ao jantar, com uma postura mais descontraída, é recebido de uma forma muito agradável, o que descatastrofiza os pensamentos negativos associados a este evento.

HENRIQUE

Amanhã, o Henrique tem uma aula dedicada à realização dos trabalhos de grupo, considerando que este ainda não se encontra integrado na turma, começa a manifestar problemas de sono, nomeadamente insónia inicial. Após diversas tentativas de adormecer, recorreu, pela primeira vez, ao seu sistema de gestão de ansiedade, na qual se deparou com várias situações consequentes do aumento da sintomatologia ansiosa, nomeadamente dificuldades em adormecer, respiração acelerada, tensão muscular, agitação motora, entre outros. O Henrique seleciona a opção de dificuldades em adormecer, permitindo ao sistema a sugestão da realização de uma sessão de relaxamento muscular.

O sistema solicita ao Henrique a focalização da sua atenção em diversos grupos musculares, de modo progressivo, iniciando pela contração e relaxamento dos músculos de ambos os braços, seguido dos da face e do pescoço, e terminando nos músculos das pernas. A fim de monitorizar o período de contração muscular, o sistema emite um alerta, sendo que

para o relaxamento muscular, emite um alerta diferente. No momento seguinte à contração e ao relaxamento dos diferentes grupos musculares, o Henrique verifica que sente menos tensão muscular, promovendo um estado de maior descontração e, consequentemente, uma noite de sono reparadora. Este descanso permitirá fornecer ao Henrique recursos biológicos que o auxiliarão na interação com os colegas na aula.

RUTE

São 15 horas, a Rute estava a estudar para o seu próximo exame, contudo, começa a experienciar alguma sintomatologia ansiosa que a impede de continuar a estudar. Neste momento, esta decide recorrer ao seu sistema de gestão de ansiedade, a fim de realizar uma sessão de relaxamento muscular progressivo, que outrora experimentara e tivera sucesso. Este sistema solicita à Rute que direcione a sua atenção para os diferentes grupos musculares gradualmente, iniciando pela contração e relaxamento dos músculos do braço dominante, seguido dos do braço não dominante, posteriormente dos da face e do pescoço, dos do peito, ombros, parte superior da coluna e abdómen, depois dos da perna dominante, e terminando nos músculos da perna não dominante. A fim de monitorizar o período de contração muscular, o sistema emite um alerta, sendo que para o relaxamento muscular, emite um alerta sonoro diferente. Após a sessão de relaxamento muscular progressivo, a Rute sente uma redução da sintomatologia ansiosa, o que permitiu que esta retomasse os estudos e aumentasse o seu rendimento.

RUTE

No decorrer da época de exames, a Rute manifesta sempre maiores níveis de ansiedade, que interferem não só com o seu rendimento académico, mas também com algumas áreas do seu quotidiano. Uma das atividades prazerosas que auxiliam a Rute a reduzir os seus níveis de ansiedade consiste no colorir formas, especialmente mandalas. Quando o seu sistema de gestão de ansiedade obtém a informação de que a Rute se encontra mais ansiosa, sabendo desta preferência previamente, sugere-lhe esta atividade durante um período aproximado de 20 minutos, normalizando, deste modo, os seus níveis de ansiedade, promovendo, consequentemente, o aumento do seu rendimento académico.

CARLOS

O Carlos chega a casa, após um longo dia de trabalho. Atendendo a que ainda se encontra bastante tenso e com elevados níveis de ansiedade, devido à sobrecarga de tarefas e

as várias situações de tensão sucedidas com os alunos, decidiu recorrer ao sistema de gestão de ansiedade. Como a sua família regressaria a casa somente na hora seguinte, resolveu realizar uma sessão profunda de relaxamento muscular progressivo, que envolve 16 grupos musculares. O sistema solicita a Carlos que se acomode numa posição confortável e se concentre progressivamente nos diversos grupos musculares, iniciando pela contração e relaxamento dos músculos do antebraço e mão dominante, seguido dos bíceps dominante, do antebraço e mão não dominante, dos bíceps não dominante, da testa, da parte média da face e nariz, da parte inferior da face e queixo, do pescoço, do peito, ombros e parte superior das costas, do abdómen, da coxa dominante, dos gémeos dominantes, do pé dominante, da coxa não dominante, dos gémeos não dominantes e, por fim, do pé não dominante. De modo a monitorizar o período de contração e relaxamento musculares, o sistema disponibiliza um guia por voz humana, que fornece as indicações requeridas para toda a sessão de relaxamento. Posteriormente a este processo, o Carlos, gradualmente, começa a mover os diversos grupos musculares, sentindo uma menor tensão e maior descontração, como pretendia.

RUTE

A Rute encontra-se em mais um dos seus bloqueios de estudo, visto que se depara com três exames na mesma semana. O seu sistema de gestão de ansiedade deteta vários sinais indicadores de que a Rute se encontra com elevados níveis de ansiedade. Perante tal situação, este sugere-lhe que inicie a realização de uma técnica de *mindfulness* baseada na atenção no momento presente, uma vez que esta se encontra num café à beira do mar. Deste modo, o sistema aconselha-a a posicionar-se confortavelmente e a fechar os olhos, se assim se sentir mais tranquila, indicando que deverá direcionar a sua atenção para o seu sentido auditivo. Assim sendo, a Rute coloca os seus fones, que, para além de capturar todos os sons naturais provenientes do exterior, permite, igualmente, continuar a ouvir as indicações do sistema relativas à sessão de *mindfulness*. Nesse sentido, o sistema sugere que a Rute deverá, inicialmente, atender aos sons mais próximos de si, sendo que a mesma percecionou as pessoas a correrem no passeio, as conversas dos restantes sujeitos presentes no café e o som dos automóveis. Posteriormente, é recomendado à Rute que se comece a focar nos restantes sons presentes e cada vez mais distantes, considerando o seu tom, o seu volume e a sua vibração. Neste momento, atende ao som das ondas a esbater na areia, ao som das gaivotas a sobrevoar a praia e o som do vento, sentindo-se progressivamente mais serena e relaxada, promovendo o regresso à sua sessão de estudo.

CARLOS

Desde que o Carlos iniciou a utilização do sistema de gestão de ansiedade, começou a realizar caminhadas regulares, de cerca de meia hora. O sistema deteta que, mais uma vez, o Carlos inicia a sua caminhada, porém, um pouco mais ansioso do que usualmente. Por conseguinte, convida o Carlos a experimentar uma técnica de *mindfulness* centrada no momento presente. Enquanto caminha, o sistema, com recurso a indicações fornecidas por uma voz humana, previamente selecionada, solicita que este atenda à alternância dos seus passos, à sensação dos seus pés no momento em que tocam no solo, ao ritmo da caminhada, à sua respiração, assim como às sensações que as condições climatéricas lhe proporcionam. No regresso a casa, o Carlos experiencia uma sensação prazerosa no corpo e na mente, concluindo que esta técnica também se revela eficaz na gestão da sua ansiedade.

CARLOS

O Carlos chega a casa após um dia *stressante* repleto de aulas e de reuniões. Ao visualizar, a sua agenda para o dia seguinte, constata a existência de reuniões consecutivas, o que restringe o seu tempo para a concretização de um projeto a entregar no próprio dia. Ao consciencializar-se desse facto, começa a manifestar sintomatologia ansiosa, cuja informação é obtida pelo seu sistema. Num outro momento de ansiedade, o sistema verificou que o Carlos conseguiu concretizar na totalidade, e com sucesso, a técnica de *mindfulness* centrada no momento presente, durante um período temporal de cinco minutos, sugerindo-lhe, então, a mesma técnica, porém, com uma duração mais prolongada. O Carlos concordou com o aumento do período para a realização da técnica, sendo que, após a execução da mesma, sentiu-se mais tranquilo e sereno, o que promoveu uma reflexão sobre uma possível solução que permitisse realizar todas as tarefas agendadas para o dia seguinte, de modo eficiente.

CARLOS

O sistema reconhece que o Carlos tem manifestado maiores níveis de *stress* no decorrer da última semana. Ao constatar que o Carlos se encontra em casa, sugere-lhe uma nova técnica de redução de ansiedade, a coloração de formas. O Carlos decide experimentar esta técnica, no entanto, após algum tempo de se encontrar a colorir um mandala, começa a experienciar maiores níveis de *stress* e de ansiedade, optando por desistir da tarefa, por considerar que a mesma não se revela eficaz. Deste modo, embora o sistema tenha conhecimento de que o docente detém interesse pela prática de exercício físico, ao constatar

que são 23h, propõe, como atividade alternativa de redução de ansiedade, a concretização de uma sessão de relaxamento muscular progressivo, que previamente se revelou eficaz em situações semelhantes. O Carlos, ao constatar esta funcionalidade do seu sistema, sente-se, assim, motivado para o uso da mesma, decidindo concretizar a prática da sessão de relaxamento.

RUTE

A Rute encontra-se no início da época de exames. Como o sistema tem conhecimento que este consiste num período de elevada ansiedade para a aluna, este propõe diariamente, antes de descansar, que a Rute realize uma técnica de relaxamento muscular progressivo de quatro grupos musculares. À medida que o sistema verifica que a Rute domina esta técnica, convida-a a aumentar o número de grupos musculares a relaxar, a fim de proporcionar um maior período de tempo exclusivamente dedicado à redução da ansiedade e, consequentemente, promover uma melhor qualidade de descanso, rentabilizando, assim, os seus períodos de estudo.

RUTE

A Rute encontra-se em mais um período de avaliações e, como é usual, exibe naturalmente maiores níveis de ansiedade. Como o sistema tem conhecimento de que a Rute, durante esta época, permanece muito tempo em casa, este convida-a a praticar exercício físico ao ar livre. No entanto, a Rute, como não aprecia a prática de desporto, recusa essa sugestão e solicita uma estratégia alternativa. O sistema propôs, então, uma estratégia de redução da ansiedade com recurso à orientação do foco atencional para estímulos externos à fonte de ansiedade, sendo, neste caso, a necessidade de estudar. Considerando as preferências da Rute, disponibiliza um leque de atividades distratoras, tais como ler, ouvir música, ver um episódio da sua série preferida, colorir formas, entre outras. Deste modo, a Rute seleciona a atividade que pretende realizar, durante um período de tempo a definir, a fim de normalizar os seus níveis de ansiedade e retomar a sua sessão de estudo.

HENRIQUE

No final de uma semana atribulada de aulas e de trabalhos académicos, o Henrique tem a oportunidade de passar o fim de semana junto da sua família. Os momentos em família despoletam, no Henrique, sentimentos de calma e de tranquilidade. Durante o fim de semana, o sistema de gestão de ansiedade reconhece que o aluno experiencia menores níveis de

ansiedade, propondo, assim, um exercício de treino de competências. A fim de concretizar esta estratégia, o sistema fornece vários cenários que objetivam a interação social, visto consistir na principal situação desencadeadora de ansiedade para o Henrique, sendo o seu principal objetivo a promoção da reflexão acerca de possiveis respostas às situações, de modo a que, quando perante as mesmas, consiga responder eficazmente. Deste modo, o seu sistema questiona-o como é que iniciaria uma conversa virtual com outros colegas, sendo que o sistema realiza o registo das respostas do aluno, caso assim o pretenda. À medida que o Henrique responde eficazmente a cada um dos cenários propostos, o sistema disponibiliza progressivamente cenários com maior carga ansiosa. No final deste exercício, o Henrique tem consciência que melhorou as suas competências sociais, encontrando-se mais preparado para lidar com esses cenários em contexto real.

HENRIQUE

Após uma semana de interação via sistema de gestão de ansiedade com alguns estudantes que se encontravam a vivenciar as mesmas circunstâncias que o Henrique, este decidiu que estaria no momento de se dirigir ao espaço físico disponibilizado pela UA, de modo a interagir pessoalmente com os mesmos. No entanto, como é habitual, o Henrique começa a sentir-se nervoso, decidindo recorrer ao sistema de gestão de ansiedade, a fim de realizar uma técnica de *mindfulness*. De acordo com as suas preferências e interesses, o sistema propõe uma técnica de atenção plena, que consiste na exploração corporal. Deste modo, após se posicionar confortavelmente, o sistema indica que deverá direcionar, inicialmente, a sua atenção para o modo como respira. Seguidamente, solicita a alteração do foco atencional para as sensações presentes nas diversas zonas do corpo, começando pelos pés e tornozelos, seguidos das pernas, da coluna, abdómen e peito, dos braços e mãos, dos ombros e pescoço, terminando na cara e na cabeça. Decorridos aproximadamente cinco minutos, deverá redirecionar novamente a sua atenção para a respiração. Após concretizar esta técnica, o Henrique experiencia uma sensação de tranquilidade e de relaxamento, que potencia a sua segurança para lidar com o novo desafio. No momento em que ingressa nesse espaço físico para socializar com os seus colegas, ao transmitir uma imagem confiante e tranquila, facilitou a interação social com os restantes elementos, o que permitiu a desconstrução de algumas crenças que contribuíam para a sua ansiedade.

HENRIQUE

É a primeira vez que o Henrique recorre ao seu sistema de gestão de ansiedade, visto que tem um encontro social dentro de poucos dias e reconhece alguma sintomatologia ansiosa que o preocupa. Como o sistema obtém conhecimento de que o Henrique se encontra em casa, sugere-lhe uma técnica de relaxamento muscular progressivo de 16 grupos musculares. O Henrique inicia a realização desta técnica, porém começa a sentir-se aborrecido e sem alterações ao nível da sua sintomatologia ansiosa, acabando por desistir da prática desta estratégia. Posteriormente, o sistema verifica que não ocorreram alterações ao nível da ansiedade, assim como deteta que o Henrique não terminou a tarefa. Deste modo, questiona-o acerca do interesse pela técnica proposta, oferecendo-lhe uma sugestão alternativa para a redução da ansiedade.

Contacto com o clínico –

1ª Consulta:

Numa das primeiras consultas, a Dra. Margarida, após recolher toda a informação referente à anamnese clínica, explica ao aluno/professor o modelo terapêutico que irá ser implementado no decorrer da intervenção, nomeadamente que os pensamentos influenciam as emoções e, consequentemente, os comportamentos. Deste modo, explica ao aluno/professor no que consistem os pensamentos automáticos, indicando que estes irão ser recolhidos, durante o processo terapêutico, com recurso a um sistema de gestão de ansiedade. Entre as consultas, o sistema irá implementar a técnica de amostragem de pensamentos, de modo a recolher os pensamentos do aluno/professor em vários momentos do dia. Este sistema, ao longo do dia, recorrerá a um alerta, que solicitará ao aluno/professor o registo do seu pensamento atual.

2ª Consulta:

Na consulta seguinte, a Dra. Margarida solicita ao utente o acesso ao registo dos pensamentos armazenados no sistema, a fim de inferir as crenças que o utente demonstra acerca de si próprio, dos outros e do mundo. Neste sentido, com recurso à técnica de reestruturação cognitiva, a Dra. Margarida ensina ao aluno/professor como se realiza a modificação dos pensamentos automáticos negativos em pensamentos racionais alternativos. Complementarmente, a psicóloga indica ao aluno/professor que, recorrendo ao sistema, poderá implementar esta técnica.

Consultas de seguimento:

Após um mês da consulta anterior, a Dra. Margarida inicia a consulta questionando acerca do último mês, marcado pela época de exames, período que despoleta maior ansiedade

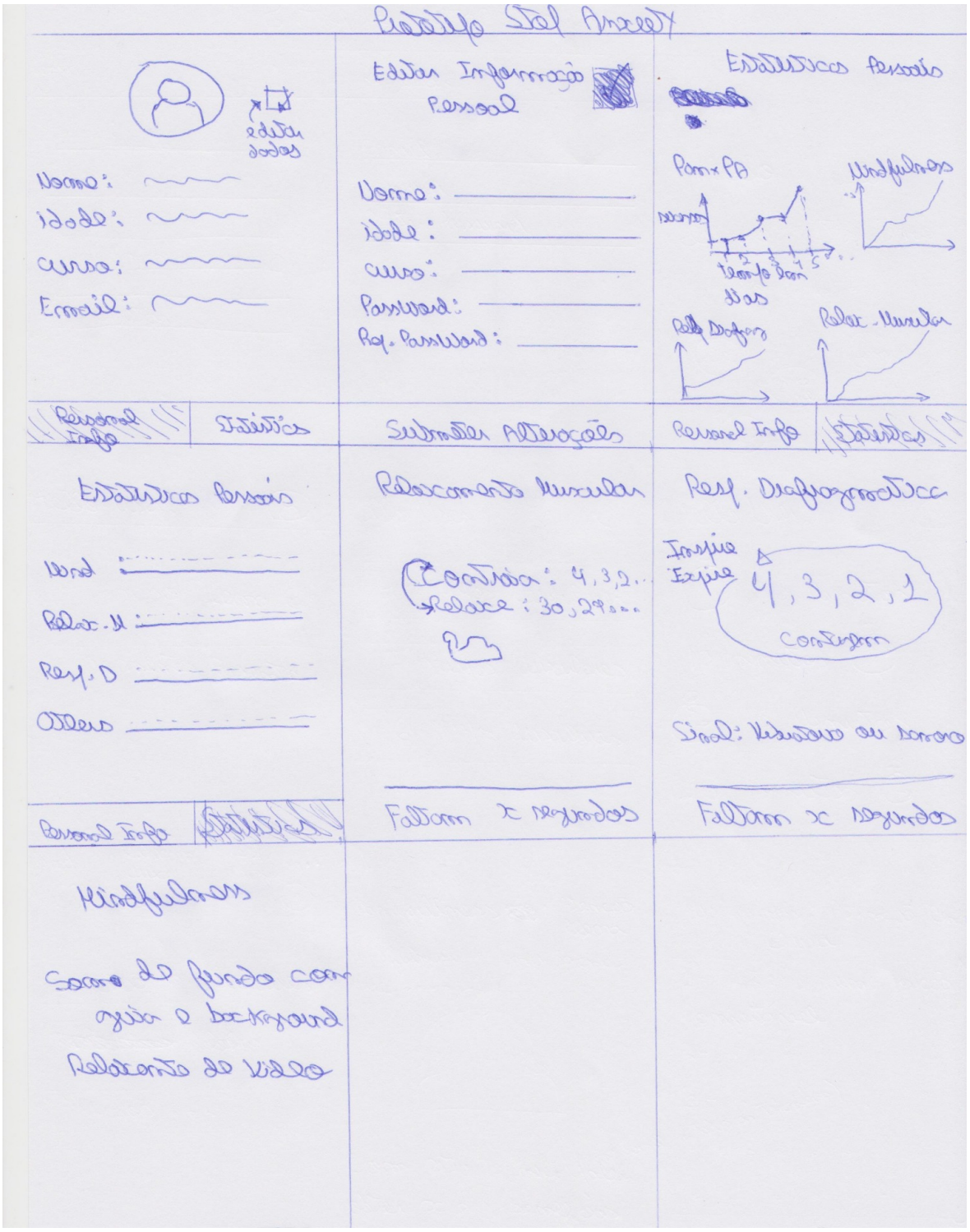
no aluno. Como haviam acordado na consulta anterior, o aluno/professor realizou o registo dos pensamentos automáticos negativos e das suas propostas de pensamentos racionais alternativos no sistema de gestão de ansiedade disponibilizado. O aluno/professor partilha essa informação com a Dra. Margarida, juntamente com algumas estatísticas que evidenciam a sua evolução desde a última consulta. No decorrer da sessão, a psicóloga verifica que o aluno/professor consegue propor pensamentos racionais alternativos, na maioria das vezes, trabalhando com este, as situações nas quais não o conseguiu realizar. Após analisar as estatísticas, afere que o aluno/professor se encontra a progredir positivamente. Assim sendo, a Dra. Margarida propõe um maior espaçamento entre as consultas, recordando que, em caso de crise, poderá contactá-la via sistema ou procurar antecipar a consulta. No final da sessão, esta salvaguarda ao utente que, como é habitual, a informação partilhada pelo sistema deixará de se encontrar disponível no final de cada consulta para a psicóloga.

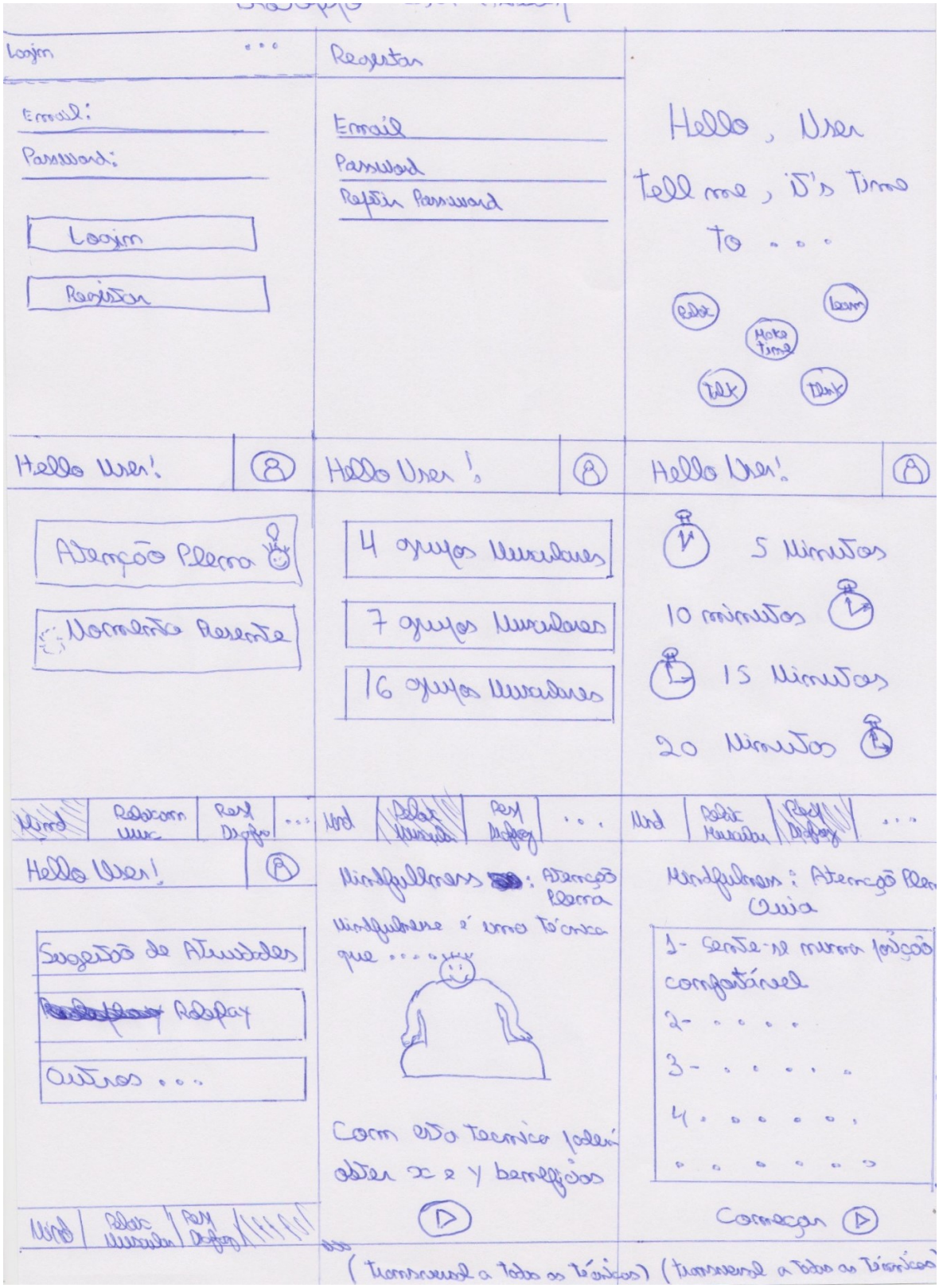
Interação social – O Henrique, que ingressou na Universidade de Aveiro na segunda fase, constatou a existência de vários grupos pré-definidos, sentindo dificuldade em se integrar. No dia da sua inscrição, os alunos voluntários no programa de integração informaram-no da existência de um sistema de gestão de ansiedade, que o poderia auxiliar no seu processo de integração. Ao contactar com o seu tutor do programa de tutoria da Universidade, teve conhecimento da existência de um espaço físico disponibilizado pela instituição destinado aos usuários do sistema, de modo a se encontrarem e a interagirem socialmente. Adicionalmente, o tutor possibilitou o acesso ao *chat* do sistema, uma vez que este se apercebeu que o Henrique era tímido e que não se sentia confortável para, num momento inicial, se deslocar a esse espaço físico. Ao interagir com outros alunos virtualmente, verificou que os mesmos também partilhavam preocupações e dificuldades semelhantes às suas, o que o tranquilizou e permitiu interagir com maior facilidade com o grupo de pares.

Psicoeducação – Mais uma vez, o aluno/professor recebe um alerta do seu sistema de gestão de ansiedade, que o questiona sobre o seguinte: "Sabias que os teus pensamentos, afetam as tuas emoções e, consequentemente, os teus comportamentos?". O facto de desconhecer esta informação, despoletou o seu interesse acerca desta temática, sendo este redirecionado para uma área própria relativa à psicoeducação referente à ansiedade, no seu sistema. Ao contactar com este modo de educação, o aluno/professor obteve uma maior consciencialização de como os pensamentos afetam os seus comportamentos.

Psicoeducação - No decorrer da hora de almoço, o aluno/docente, ao se encontrar desafogado em termos de tempo, decide procurar mais informação sobre a ansiedade. Assim sendo, este consulta o seu sistema de gestão de ansiedade, acedendo à secção reservada à literacia sobre saúde mental, uma vez que sabe que a informação presente nessa seção é baseada em literatura impiracamente validada. Esta secção disponibiliza a informação de diferentes modos, nomeadamente através de esquemas, de vídeos, de audio, de artigos cientificos, de bibliografia recomendada, entre outros. O aluno/docente, ao aceder a esta secção, reconhece que, de certo modo, aumentou o seu conheciemnto relativo a esta temática, permitindo-lhe reconhecer alguns *triggers* eficazmente.

Appendix B


Prototipo Stop Anxiety
editar dados
Nome:
idade:
curso:
Email:
Editar Informação Pessoal
Nome:
idade:
curso:
Password:
Rep. Password:
Estatísticas Pessoais
Pan x PA
Mindfulness
Relax. Muscular
Personal Info
Statistics
Submeter Alterações
Personal Info
Statistics
Estatísticas Pessoais
Mind
Relax. M
Resp. D
Others
Relaxamento Muscular
Contrair: 4, 3, 2...
Relaxe: 30, 29...
Resp. Diafragmatica
Inspire
Expire
4, 3, 2, 1
Contagem
Sinal: Vibratório ou sonoro
Personal Info
Statistics
Faltam x segundos
Faltam x segundos
Mindfulness
Somo de fundo com guia e background
Relaxante de vídeo


Login ...
Email:
Password:
Login
Registar
Registar
Email
Password
Repetir Password
Hello, User
Tell me, it's time
to ...
Relax
Learn
Make time
Talk
Think
Hello User!
Atenção Plena
Momento Presente
Hello User!
4 grupos Musculares
7 grupos Musculares
16 grupos Musculares
Hello User!
5 Minutos
10 minutos
15 Minutos
20 Minutos
Mind
Relaxam Musc
Resp Diafrag
...
Hello User!
Sugestão de Atividades
Roleplay
Outros ...
Mindfulness: Atenção Plena
Mindfulness é uma técnica que ...
Com esta técnica podem obter x e y benefícios
Mindfulness: Atenção Plena
Guia
1- Sente-se numa posição confortável
2- ....
3- .....
4. .....
.....
Começar
(transversal a todas as técnicas)
(transversal a todas as técnicas)

Appendix C

Heurísticas de Nielsen

As Heurísticas de Nielsen consistem nos dez princípios gerais do *design* de interface do usuário, propostas por Jakob Nielsen e Rolf Molich em 1990. Estas heurísticas podem ser utilizar em dois momentos do projeto: durante e após a projetação. Durante a projetação, as heurísticas são usadas como base para o bom desenho de interface focado numa boa navegação, interação e experiência. Após a projetação, são utilizadas por meio da avaliação que é realizada por especialistas em usabilidade para identificar problemas no sistema de acordo com cada heurística.

1. **Visibilidade do estado do sistema:** capacidade do sistema de informar sempre o utilizador do que se passa no momento da interação. Para tal, o sistema disponibiliza *feedbacks* instantâneos para manter o utilizador informado.

2. **Equivalência entre o sistema e o mundo real:** habilidade do sistema em comunicar de um modo percetível/intuitivo para o utilizador. Assim sendo, não se deve recorrer a linguagem técnica ou termos muito específicos. Todas as nomenclaturas devem ser contextualizadas, bem como devem de ir ao encontro do modelo mental do utilizador. O mesmo se aplica para ícones e imagens ilustrativas.

3. **Liberdade e controlo do utilizador:** capacidade de o sistema permitir que o utilizador decida autonomamente o que pretende realizar. Para tal, o sistema não deve de impor algo ao utilizador, nem decidir pelo mesmo. O ideal será sugerir e não induzir. Facilitar as "saídas de emergência", permitir desfazer ou refazer alguma ação no sistema e retornar ao ponto anterior quando estiver perdido ou em situações inesperadas.

4. **Consistência e padrões:** nesta heurística pretende-se que o sistema demonstre consistência visual e de linguagem, tanto em padrões de interação em diferentes contextos, como na linguagem utilizada. Nesse sentido, não se deve identificar uma mesma ação com ícones ou *labels* diferentes, assim como devemos tratar

aspetos similares da mesma maneira, facilitando a identificação do utilizador e ensinando-o a usar o sistema.

5. **Prevenção de erro:** de modo a prevenir o erro, o sistema deve sinalizar corretamente, cada vez que se pretende eliminar um arquivo. Deve, ainda, requerer uma confirmação das principais ações, bem como deve possibilitar desfazer o que foi feito.

6. **Reconhecer ao invés de relembrar:** capacidade de memorização de um sistema, que evita que o utilizador seja obrigado a reaprender o sistema cada vez que o acede. Par tal, é aconselhado ter auxílios contextuais no sistema, bem como ter fluxos de ações de acordo com o contexto em que o utilizador se encontra.

7. **Flexibilidade e eficiência de uso:** habilidade do sistema em ser ágil para utilizadores avançados e em ser fácil de utilizar para os utilizadores mais inexperientes, por exemplo disponibilizando atalhos de teclados, ou preenchimento automático a partir de dados anteriores.

8. **Estética e *design* minimalista:** a estética e o *design* não constituem um "extra", fazem parte do conjunto que promove a experiência, sendo, portanto, de máxima importância. Assim sendo, deve-se incitar um diálogo simples e direto, um *layout* limpo, de fácil entendimento e que apareçam em momentos necessários, contudo, deve-se evitar o recurso a cores desnecessárias e/ou excessivas, ou a utilização de elementos visuais que confundam o utilizador.

9. **Auxiliar os utilizadores a reconhecer, diagnosticar e recuperar ações erradas:** capacidade de auxiliar o utilizador a identificar e a resolver os problemas que acabam sendo inevitáveis. Para tal, deve-se apresentar mensagens

de erro claras, com textos simples e diretos, incitando soluções e não intimidando o utilizador. Um exemplo simples disso é, no caso dos formulários, os erros de campos que podem ser identificados mudando a sua cor e não somente no momento da submissão de dados.

10. **Ajuda e documentação:** apesar de uma interface intuitiva e clara evitar a solicitação de auxílio em algumas situações, deve-se manter ao alcance do utilizador, itens de auxílio para determinadas ações, assim como se deve manter auxílios fixos que podem ser acedidos à qualquer momento, em caso de dúvidas, como é o caso dos FAQs com as questões mais solicitadas.

Appendix D

Tarefas	Sucesso/Insucesso (nº de pessoas)	Tempo (segundos)	Erros (nº de erros)	Eventos não previstos
Faça o registo na aplicação.				
Realize o login na aplicação.				
Edite e complete o seu perfil com os dados necessários.				
Obtenha informações adicionais sobre a Técnica de Relaxamento Muscular.				
Configure a Técnica de Respiração Diafragmática para uma duração de 7 minutos.				
Na Técnica de Respiração Diafragmática, selecione a opção sem som.				
Realize a técnica durante aproximadamente 1 minuto				
Regresse ao menu da técnica de Respiração Diafragmática e realize a técnica durante aproximadamente 1 minuto com som.				
Realize a técnica de Relaxamento Muscular contraindo e relaxando um dos grupos musculares indicados.				
Faça o logout da aplicação.				

Guião das Tarefas

O seguinte guião descreve as tarefas que terá de realizar durante o decorrer desta sessão.

Tarefa 1: Faça o registo na aplicação.

Tarefa 2: Realize o login na aplicação.

Tarefa 3: Edite e complete o seu perfil com os dados necessários.

Tarefa 4: Obtenha informações adicionais sobre a Técnica de Relaxamento Muscular.

Tarefa 5: Configure a Técnica de Respiração Diafragmática para uma duração de 7 minutos.

Tarefa 6: Na Técnica de Respiração Diafragmática, selecione a opção sem som.

Tarefa 7: Realize a técnica durante aproximadamente 1 minuto.

Tarefa 8: Regresse ao menu da técnica de Respiração Diafragmática e realize a técnica durante aproximadamente 1 minuto com som.

Tarefa 9: Realize a técnica de Relaxamento Muscular contraindo e relaxando um dos grupos musculares indicados.

Tarefa 10: Faça Logout da aplicação.

Appendix E

Questionário PSSUQ									
1. Em geral, estou satisfeito com a facilidade de utilização deste sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
2. Este sistema foi simples de utilizar.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
3. Consegui completar as tarefas e os cenários utilizando este sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
4. Consegui completar rapidamente as tarefas e os cenários utilizando este sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
5. Consegui completar as tarefas e os cenários com eficiência utilizando este sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
6. Senti-me confortável a utilizar este sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									
7. Foi fácil aprender a utilizar este sistema.									
Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**
Comentários:									

8. Acredito que me tornaria rapidamente produtivo se utilizasse este sistema.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

9. O sistema deu mensagens de erros que me indicaram claramente como resolver os problemas.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

10. Sempre que cometi um erro durante a utilização do sistema, consegui recuperar de forma fácil e rápida.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

11. A informação fornecida pelo sistema (como ajuda *online*, mensagens no ecrã ou outra documentação) foi clara.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

12. Foi fácil encontrar a informação que precisava.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

13. A informação fornecida pelo sistema foi fácil de entender.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

14. A informação foi eficaz para me ajudar a completar as tarefas e os cenários.

Concordo totalmente **1** **2** **3** **4** **5** **6** 7 **Discordo totalmente** **NA**

Comentários:

15. A organização da informação que o sistema transmitiu foi clara.

Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**

Comentários:

16. A interface do sistema foi agradável.

Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**

Comentários:

17. Gostei de utilizar a interface deste sistema.

Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**

Comentários:

18. Este sistema tem todas as funcionalidades e capacidades que eu esperava.

Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**

Comentários:

19. Em geral, estou satisfeito com este sistema.

Concordo totalmente	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Discordo totalmente**	**NA**

Comentários:

Appendix F

Questionário SUS

1. Eu gostaria de utilizar esta aplicação com frequência.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

2. A aplicação é desnecessariamente complexa.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

3. A aplicação é fácil de utilizar.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

4. Preciso de ajuda para utilizar a aplicação.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

5. As diversas funções desta aplicação foram bem integradas.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

6. Existem muitas inconsistências na aplicação.

Discordo Fortemente					Concordo Fortemente
	1	2	3	4	5

7. As pessoas aprenderiam rapidamente a utilizar a aplicação.

Discordo Fortemente						Concordo Fortemente
	1	2	3	4	5	

8. A aplicação é muito complicada de utilizar.

Discordo Fortemente						Concordo Fortemente
	1	2	3	4	5	

9. Senti-me bastante confiante a utilizar a aplicação.

Discordo Fortemente						Concordo Fortemente
	1	2	3	4	5	

10. É preciso aprender muitas coisas antes de se utilizar a aplicação.

Discordo Fortemente						Concordo Fortemente
	1	2	3	4	5	