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Degree in Informatics Engineering

Co-designing an eHealth Intervention to Support the Self-Management of Fibromyalgia

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Abstract

Fibromyalgia is a rheumatic pathology that causes a wide range of symptoms that can appear individually, or in sets, such as fatigue, sleep disorders, attention, and concentration deficit, also having connection with musculoskeletal, psychological, cardiovascular, gastrointestinal disorders. This pathology has a greater predominance in women and, in Portugal, for every man there are six women with the diagnosis and a total of approximately two hundred thousand people (2.1% of the population).

The non-pharmaceutical way to mitigate these symptoms is through physical therapy. Considering the pandemic moment in which we live, there have been many difficulties in having physical therapy sessions because of the fear of infection through contact with their physical therapists. There are also people who live in more isolated areas and with little access to healthcare, who often must travel to larger urban centers to get the care they need. Moreover, these people have difficulties in self-managing their illness, where depending on the day their symptoms can get worse, and they do not know how to deal with them.

Currently, there is no specialized solution for people with this diagnosis that solves these problems, so this dissertation aims to study and design a solution that allows people diagnosed with fibromyalgia to self-manage their pathology, as well as have a closer contact with their physical therapist, by being able to perform their sessions in a hybrid way, i.e., in person or remotely.

This solution was designed using a Co-Design approach, following the Design Thinking methodology, where the community (people with the diagnosis, physiotherapists, researchers and academics) were involved in all stages of the process, from problem identification and idealization of their solutions, to prototyping and its validation. This solution involved the development of a mobile application, having several important components, such as self-management, telerehabilitation, motivation, community and communication. In order to evaluate the whole process and the usability of the solution, tests were performed with end users who had not yet participated in the design of the solution.

Keywords:

Fibromyalgia, Physical therapy, Co-Design, Design Thinking, Mobile app, Self-Management, Telerehabilitation

Resumo

Fibromialgia é uma patologia reumática que provoca um conjunto alargado de sintomas que podem aparecer individualmente, ou em conjuntos, tais como fatiga, distúrbios de sono, défice de atenção e concentração, tendo também ligação com perturbações músculo-esqueléticas, psicológicas, cardiovasculares, gastrointestinais.

Esta patologia tem uma predominância maior nas mulheres, e, em Portugal, para cada homem há seis mulheres com o diagnóstico e um total de aproximadamente duzentas mil pessoas (2,1% da população).

Considerando o momento pandémico em que vivemos, tem havido dificuldades em ter sessões de fisioterapia devido ao medo de infeção através do contacto com os seus fisioterapeutas. Também há pessoas que vivem em áreas mais isoladas e com pouco acesso aos cuidados de saúde, onde para obterem os cuidados que necessitam têm de se deslocar a centros urbanos maiores. Além disso, estas pessoas têm dificuldades em autogerir a sua doença, onde dependendo do dia em que os seus sintomas podem piorar, e não sabem como lidar com eles.

Atualmente, não existe uma solução especializada para pessoas com este diagnóstico que resolva estes problemas, pelo que esta dissertação visa estudar e conceber uma solução que permita às pessoas diagnosticadas com fibromialgia autogerirem a sua patologia, bem como terem um contacto mais próximo com o seu fisioterapeuta, podendo realizar as suas sessões de uma forma híbrida, ou seja, pessoalmente ou à distância.

Esta solução foi desenhada através da utilização de uma abordagem Co-Design, seguindo a metodologia Design Thinking, onde a comunidade (pessoas com o diagnóstico, fisioterapeutas, investigadores e académicos) esteve envolvida em todas as fases do processo, desde a identificação dos problemas e idealização das suas soluções, até à prototipagem e sua validação. Esta solução passará pelo desenvolvimento de uma aplicação móvel, tendo várias componentes importantes, tais como a auto-gestão, telereabilitação, motivação, comunidade e comunicação. De forma a avaliar todo o processo e a usabilidade da solução, foram realizados testes com utilizadores finais que ainda não tinham participado no desenho da solução.

Palavras-chave:

Fibromialgia, Fisioterapia, Co-Design, Design Thinking, Aplicação móvel, autogestão, telereabilitação

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Acronyms and Symbols

FM	Fibromyalgia
RP	Rheumatic Pathology
PD	Participatory Design
CC	Co-Creation
DT	Design Thinking
RA	Rheumatoid Arthritis
SL	Systemic Lupus Erythematosus
FMR	Functional Magnetic Resonance
SRA	Swedish Rheumatism Association
API	Application Programming Interface
CDN	Content Delivery Network

Chapter 1

Introduction

Fibromyalgia (FM) is a rheumatic pathology (RP) marked by chronic widespread pain, migratory behavior, and intensity fluctuations over time. Fatigue, sleep disturbances, and concentration/memory deficits are all common symptoms (Littlejohn & Guymer, 2018). It is linked to musculoskeletal, psychological, cardiovascular, gastrointestinal, and endocrine disorders (LP, 2013).

Patients with this pathology indicate several limitations in daily activities, including at work, which leads to a high level of absenteeism. Therefore, FM can have a significant impact on society, families, and the economy. In Portugal, the prevalence of FM is 1.7% [1.1%; 2.1%], which corresponds to approximately 200,000 people, and approximately 21.2% of the population (95% CI: 19.9; 22.5%) have a RP. FM is the third most functionally important RP among the Portuguese population and is the most associated with reduced quality of life. It is the RP most strongly associated with anxiety and the second most important RP related to depression (JC et al., 2016).

1.1. Motivation

Unfortunately, not all healthcare delivery systems are able to provide sufficient care for patients with chronic diseases, and the COVID-19 pandemic has only made the situation worse. In Portugal, during April 2020, there was a decrease of around 35% in hospital consultations compared to 2019. In addition, this decrease was also observed at the level of primary healthcare, with a reduction in the number of consultations of 73% in April (ERS, 2020). These

data can be justified by the postponement/cancellation of non-urgent appointments, as well as by the fear of people being contaminated when traveling to these appointments, thus reducing the demand for medical services. Independently of the pandemic, this was already verified in people who live far from their medical centers, having difficulty in moving around because of the transportation and appointment times. This scenario will have consequences not only at the level of chronic pain, regarding its monitoring and treatment, but also at the social level, identifying nociplastic, neuropathic and nociceptive consequences, responsible for the worsening of symptoms (Clauw et al., 2020).

There is a need to implement strategies that mitigate the effects of lack of support from the care delivery system due to the current COVID-19 pandemic context that currently exists, and other reasons mention before, considering that the recommendation for treating patients with FM is to use non-pharmaceutical approaches first (Plow & Golding, 2017), such as exercise and symptom self-management education (Macfarlane et al., 2017).

In this context, research has reinforced the relevance of telerehabilitation, which is defined as an intervention model that uses telecommunication technologies to provide health services at a distance. Telerehabilitation has been gaining strength in the research context for continued support to vulnerable groups. Studies show that telerehabilitation is acceptable, safe, effective, facilitating contact and adherence to the intervention (Plow & Golding, 2017).

1.2. Problem

Currently, there is no technological solution for people diagnosed with FM that encompasses both issues related to telerehabilitation and the condition’s self-management in a single platform, with these being the main topics that motivated the SELFIE project and this dissertation. The solutions researched, analyzed, and presented in chapter 2.7, show some functionalities that can be reused, but are not contextualized and specialized for the context of fibromyalgia.

Many of these people have neither the financial nor the time availability to have specialized interventions for their pathology with physical therapists over an extended period. During this period the feeling of improvement is noticeable, but when it is over everything goes back to the starting point, as they do not have the necessary tools to continue to perform the exercises frequently without feeling lost in the process, either because they don't know what exercises to perform, or they can't remember how to perform them.

In addition, sometimes people's symptoms tend not to be understood by family and

friends, which can be very frustrating, as it feels that they are fighting against something that is not recognized. Basically, they tend to feel alone, as they have no one outside the medical field with whom they can talk openly and feel understood. This point can become demotivating, causing people not to comply with the physical exercise recommended by their physical therapists, becoming detrimental to the improvement of their symptoms.

The proximity with the physical therapist is also a very relevant aspect. Many times it is only possible to talk and clarify doubts with the physical therapist when there are only presential sessions. For example, certain physical exercises have been prescribed and if existential doubts arise, these will hardly be clarified in time for the next session. This lack of proximity does not help the patient-therapist relationship, which is very important for these people.

Finally, these people tend to have flare-ups of symptoms over time and often find no moments of improvement during that time, because the worst moments tend to overshadow the best. Without a record of the evolution/regression of these symptoms over time, it becomes complicated to understand the real health status of the person, as well as to know how to manage it more efficiently.

1.3. Proposed solution

The purpose of this dissertation is to study, design and implement a solution following a Co-Design methodology, i.e., with the involvement of different stakeholders, people dealing with the pathology, with the focus on telerehabilitation and the improvement of condition self-management.

Given the problems presented in section 1.2, the solution considered some key components.

A condition self-management component is essential, thus allowing the patient to have greater control over the state of the condition as well as its evolution/regression. In addition to this, tools are provided for these patients to perform physical exercise correctly in an autonomous way, thus promoting the independence of the physical therapist in the performance of physical exercise.

To motivate the users of the platform and promote a sense of belonging to a community, a gamification system was implemented, where group challenges are created monthly by the physical therapists. Each challenge has the goal of walking a certain set of meters through the walks, among all the members of the group. In this way, besides challenging people to exercise, it also promotes competitiveness and group spirit, encouraging people to meet to accomplish

the challenge.

In order to improve the proximity and relationship between physical therapist and patient, a chat is available so that they can establish contact whenever needed. In addition, chat rooms are provided for each group challenge so that they can motivate each other and arrange to go for the walks together.

The sessions component is extremely important to be able to perform telerehabilitation between the patient and the physical therapist. This component was prepared for three types of interventions: remote, presential and autonomous, thus promoting a hybrid intervention plan. In all of them, the set of exercises that the patient performed or will have to perform is made available, accompanied by visual aids in video and text, so that later they can be done without the help of the physical therapist. In the case of remote interventions, they are performed via video call directly within the solution.

This solution has two actors: the patients; and the physical therapists. Each of them can either have their own specific application, or an application that is used by both, but that is adapted to their distinct roles. This application is initially mobile, with the intention of later becoming available in a web version. For the purposes of this dissertation, the focus is on the use of the application by patients, and the version for use by physical therapists will be done in future work.

1.4. Main Foreseen Contributions

The main contributions as results of this dissertation are:

- **Design Process in a Co-Design Methodology:** Explanation of how a solution was designed for people with the diagnosis of fibromyalgia, based on their involvement in all phases of the process.
- **Main Components:** Findings of which main components a solution for people with this condition should support.
- **Solution development:** Development of the solution designed in the previous phases of the research process. This development encompasses the mobile application and the API with the relational database, having integrations with some services.
- **Usability tests:** In order to evaluate the quality of the developed solution, formal tests were performed. These served to validate the functionalities of the application, as well as its usability.

1.5. Document Structure

This document is structured as follows:

- **Chapter 1 - Introduction:** As the name implies, this chapter serves as an introduction to the subject of this dissertation, describing the motivation and the problem at hand, as well as the initial ideas for the solution that emerged throughout the development of this dissertation.
- **Chapter 2 - Related Work:** This chapter aims to describe some important concepts to understand the context of this dissertation, as well as related work on this topic. It is described how the important concepts of user-centered design/research work, a more detailed explanation of fibromyalgia is provided, the concept of gamification is introduced, and three works that are related to this research are presented.
- **Chapter 3 - Research Process:** This chapter describes in detail the process of designing the solution through the workshops, presenting all the information collected in each one of them, as well as the brainstorming carried out in order to identify the main components that the application should support in a first phase, ending with the creation of prototypes and their validation.
- **Chapter 4 - Solution:** Chapter 4 presents the solution developed for this thesis through a detailed explanation of the functionalities with figures of it. It presents its general architecture and the services used to develop some key functionalities of the solution.
- **Chapter 5 - Evaluation and results:** This chapter presents the evaluation of the main features of the solution, describing how the tests were performed, the feedback obtained and the results with a small data analysis.
- **Chapter 6 - Conclusion and future work:** Chapter 7 presents the conclusions drawn from the completion of this dissertation and indicates future work that will need to be carried out, as well as some new ideas that may improve the solution.

Chapter 2

Background and Related Work

This chapter aims to review all the essential concepts and previous work for the understanding and study of this work. The core principles of this project, such as what fibromyalgia is, are presented first, followed by a contextualization of the design and development process. Finally, a collection of works related to the subject is presented.

2.1. Fibromyalgia

Fibromyalgia (FM) is the diagnosis given to individuals with chronic widespread musculoskeletal pain. Along with the pain, FM has more symptoms, like sleep problems (person wakes up tired), physical exhaustion, cognitive difficulties (Häuser et al., 2015) or even depression. A characteristic of the person with FM is the great sensitivity to touch. Although some patients have only experienced one of these symptoms in their lifetime, the likelihood of having multiple symptoms is much higher (Clauw, 2009).

The definition, pathogenesis, and treatment of this pathology are all debatable, and some even question its existence. Over the years this pathology has had different diagnostic criteria, for instance, in 1990 multiple tender points (tender areas in muscles and muscle-tendon junctions) and chronic widespread pain were required as part of a diagnosis, while in 2010 tender points were excluded, allowing for less extensive pain, and relying on patient-reported somatic symptoms and cognitive difficulties (Häuser et al., 2015).

In Portugal, the condition affects 2.1% of the population, which means that over 200,000 people have been diagnosed with FM, with six women diagnosed for every man who has a

positive diagnostic (Alvarez et al., 2021). Portugal has more FM patients than other Western European nations such as Spain, France, Germany, and Italy, indicating a larger need to explore and examine suspect FM factors and symptoms. In terms of the economic impact of this illness, it is predicted that diseases with chronic pain-related symptoms can result in an average of six annual visits, resulting in direct and indirect expenditures to public health (Branco et al., 2010).

Currently, doctors suspect this diagnosis when individuals present with multifocal pain that cannot be explained by another event such as damage or inflammation in affected regions of the body. One of the major differences between this pain and peripheral pain is its duration and location, as it decreases and increases over time in different areas of the body. Because of these characteristics a physical examination is usually not necessary for diagnosis, the only exception is to validate the patient's sensitivity to touch. It is common for FB to present in a similar way to other diseases such as *systemic lupus erythematosus (SLE), rheumatoid arthritis* and *ankylosing spondylitis,* and thus confuse the diagnosis (Clauw, 2009). A diagnosis typically takes more than two years, with an average of 3.7 consults (Macfarlane et al., 2017).

To treat this condition, drugs such as *pregabalin (Lyrica), duloxetine (Cymbalta), milnacipran (Savella), amitriptyline (Elavil), cyclobenzaprine (Flexeril),* or *gabapentin (Neurontin)* are used. Each of these medications is taken for a variety of diseases, including depression and nerve pain (Bilodeau, 2020).

While medication is primarily focused on reducing pain, there are other strategies that can be used, such as physical therapy, to address the consequences of illnesses, i.e., pain, fatigue, deconditioning, muscle weakness, sleep disturbances, among others.

Since one of the main symptoms of FB is widespread musculoskeletal pain, a physical therapist with knowledge in anatomy and kinesiology (study of movement) can help to regain control of the disease by relieving pain symptoms, reducing the fatigue by developing specific stretching and strengthening programs to meet patients' individual needs. There is now a wide range of resources, from deep tissue massage to ice and heat packs to hydrotherapy, and these allow physical therapists to help patients work their muscles more, stretch for flexibility and move their joints through range of motion exercises (Bruce Fulghum, 2020).

In general, the well-being of people with a diagnosis improves through physical activity. This was verified through different forms of training studied in several clinical trials, including water and land exercise regimens involving aerobic operations, strength, flexibility, and mixed format exercises. Each of these regimens has different results. Regarding aquatic exercises, these reduce pain, fatigue and depression and improve health-related quality of life. Strength training has been associated with large improvements in overall well-being and physical

function, and mixed exercise training (combination of aerobic exercise and/or strength and/or flexibility) produce large improvements in physical function (Busch et al., 2011).

In addition, self-management of the disease is very important, because not all drugs have the expected effect, thus having some limitations. Those suffering from FM frequently employ a range of ways to deal or decrease their symptoms.

There are formal self-management training programs for people with FM, in which health professionals educate and give knowledge to people about their pathology and how to manage it to minimize their symptoms. These programs tend to have different knowledge sharing strategies, in which the self-management strategies that people may already be using are improved in the first phase, then new ones are introduced and finally an approach is made to apply this knowledge in practice, with detailed instructions (Sandstrom Francis J Keefe et al., 1998).

2.2. Citizen Science

Citizen Science is an increasingly popular research technique used to conduct research about a certain topic by involving nonprofessionals, i.e., not scientists by profession, in the collection, analysis and curation of scientific data.

Depending on the project scale, citizen science can engage participants from different countries, increasing the amount and quality of data that can be collected with less effort and cost. Committed volunteers can provide a solid technique of capturing data for long-term monitoring that is less sensitive to the vicissitudes of financial availability than professional monitoring (Pocock et al., 2014). Citizen science project efforts also focus on helping participants learn about what they are observing or performing, thus experiencing the process by which scientific research are conducted (Bonney et al., 2009).

On the other hand, this technique can be less effective when the approach is complicated and demanding, or when recording must be repeated over time or in multiple locations, participation is likely to be diminished. Volunteers need to be recruited and trained to respect certain protocols and know how to perform the tasks to be carried out so that the quality of data can be the most reliable There can be contradictions between participants' and organizers' motivations - what a researcher considers significant may not be of interest to an 'ordinary' individual. People participate because they are interested, curious, concerned, or simply want to have fun. Participants may expect immediate local action as a result of their participation, yet this may not be the project's goal. To control the expectations of the participants, the

project's goals must be clearly stated (Pocock et al., 2014).

An example of the citizen science is the Eyewire project, in which people help deduce the structure of neurons in the human brain using functional magnetic resonance (FMR) scans. These contributions are mapped to machine learning classifiers to create a detailed map of the collections of neurons (connectomes) in the back of the human eye. The goal is for neuroscientists to have a better understanding of how humans perceive visual stimulations. This initiative already had 13,000 participants from 130 countries at the time. Each participant interacts with the system via a game that consists of exploring colorful 3D maps relating to neurons and reconstructing a 2D map by coloring areas of the map that are not colored. Figure 1 shows how the coloring can be done in the game (Tinati et al., 2017).

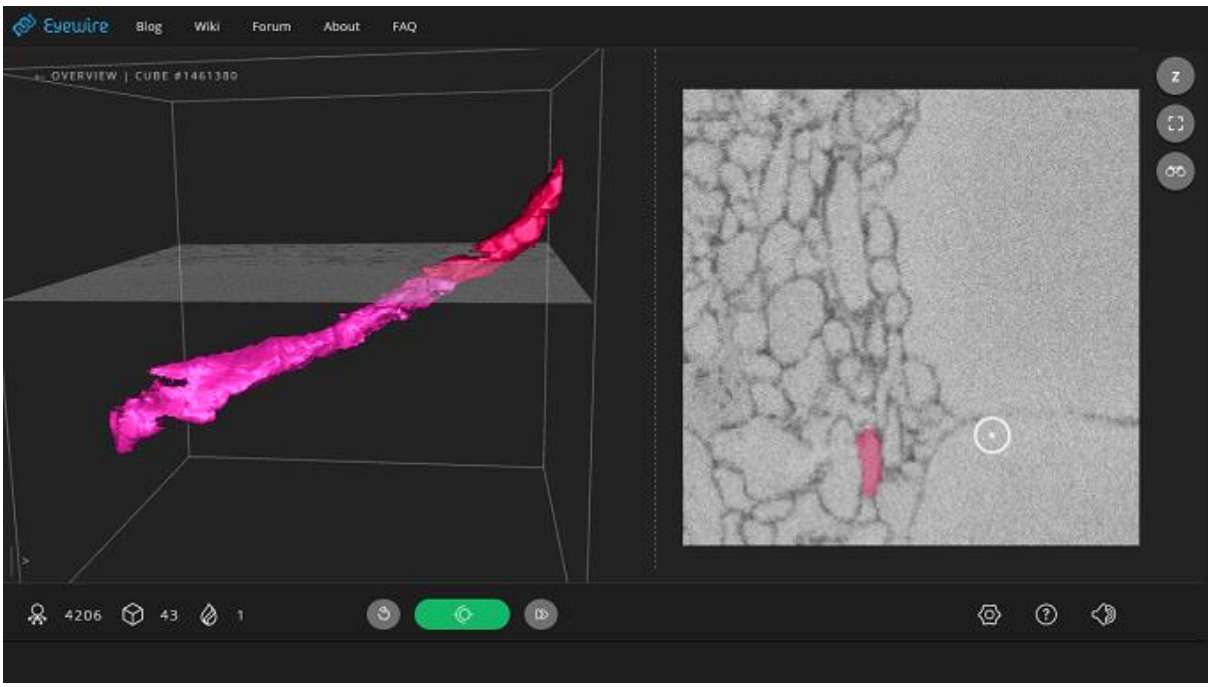

Figure 1 - EyeWire gameplay (https://citizensciencegames.com/games/eyewire/)

2.3. Participatory Design

Participatory Design is a developing subject of study, as well as a growing practice among designers, that consists of the involvement of all stakeholders (e.g., employees, partners, clients, end users) in the design process of a product to ensure a better fit between technology and the ways in which people (want to) perform their work, thus satisfying their user experience (Kensing & Blomberg, 1998). Participatory design is a method of approaching design processes and procedures rather than a design style. It can be used in a variety of sectors, including software design, urban design, graphic design, and even healthcare.

In theory, this approach makes perfect sense, as users are the ones that will use the design,

but it is not that linear, given most consumers are not usability experts and a small set of people cannot represent the usability of all the people who will use the design.

Thus, participatory design must be applied as a strategy to gather relevant contributions from users, but it is not 100% reliable. The designers understand better the difficulties of users through these contributions, as well as what their experience should be for them to feel better when using the design. In conclusion, for user-centered products this participatory design strategy is critical (Gomes & Berga, 2021).

2.4. Co-Creation and Co-Design

Depending on the context in which it is used, co-creation (CC) has many different definitions, but in a high-level way CC takes advantage of the users' understanding of their own requirements and daily lives, as well as their ability to be creative. In contrast to participatory design co-creation innovations may not result in objects that the participants will utilize. The user is involved in the gathering of information, the generation of ideas, and the development of concepts. The designer/researcher creates tools for idea generation and the innovation process itself. The tools for ideation are developed in collaboration between the designer/researcher and the user. Afterwards, the designer/researcher puts the concepts into action (Nielsen, 2010).

On the other hand, as the name implies, co-design is a collaborative methodology, in which the design is made with people rather than for them, thus encouraging those people who are directly affected by a certain topic, problem, or process to take part in its design and sometimes also in its implementation. The goal is to involve people in the design of improvements, innovations, utilizing their collective experiences to provide the best possible services and outcomes. It does not focus only on involving the voices of end users, but also on building mutual understanding throughout the service. It is imperative that all the people are involved in solving complex and entrenched social issues (Ann Mckercher, 2010). The concept is very similar to PD, however, CC focuses more on imparting skills to the process's beneficiaries, whereas PD emphasizes the involvement component, although they are both part of a design that is centered on the people engaged (Casali, 2013).

There are four principles when using this methodology (Ann Mckercher, 2010):

- **Share Power**: When power imbalances go unrecognized and untreated, the individuals with the most power normally have the most impact on the decisions, regardless of the quality of their knowledge. By sharing the power this behavior will change and all

people will share their inputs no matter what, thus increasing your sense of belonging.

- **Prioritize relationships**: For a better process and output, better relationships, social connections, and trust between all the people involved should be established to open the way for conversations, discussion, and debates, which will bring better ideas.
- **Use participatory means**: There is variety of ways for people to participate and express themselves, such as through visual and oral approaches, rather than relying on writing, presentations, and lengthy reports. On Participatory techniques the idea is to encourage the active participation in the discussion, instead of just the delivery knowledge.
- **Build Capacity**: Many people need support and encouragement to embrace new ideas, give their opinion or even share them. Therefore, the persons in charge must assist them by providing mentorship.

2.5. Design Thinking

Design Thinking (DT) is an iterative process that involves understanding the user, challenging assumptions, and redefining problems in order to identify alternative strategies and solutions that might not be apparent at the outset, thus presenting a proposal focused on creativity and innovation. Simultaneously, DT offers a problem-solving strategy based on solutions. It is both a way of thinking and working as well as a set of practical techniques. This process is based on a strong desire to learn more about the people for whom we are making products or services. It enables us to observe and empathize with the target user.

DT is basically a CC and CD methodology, with a large Participative Design component, since it involves the end-user in the whole process of creating a technological solution, from the problem definition, ideation of the solution, to its creation and testing.

Therefore, design thinking is structured into five fundamental stages shown in Figure 2 (Dam, 2021):

1. **Empathize** - Research Your Users' Needs
2. **Define** - State Your Users' Needs and Problems
3. **Ideate** - Challenge Assumptions and Create Ideas
4. **Prototype** - Start to Create Solutions
5. **Test** - Try Your Solutions Out

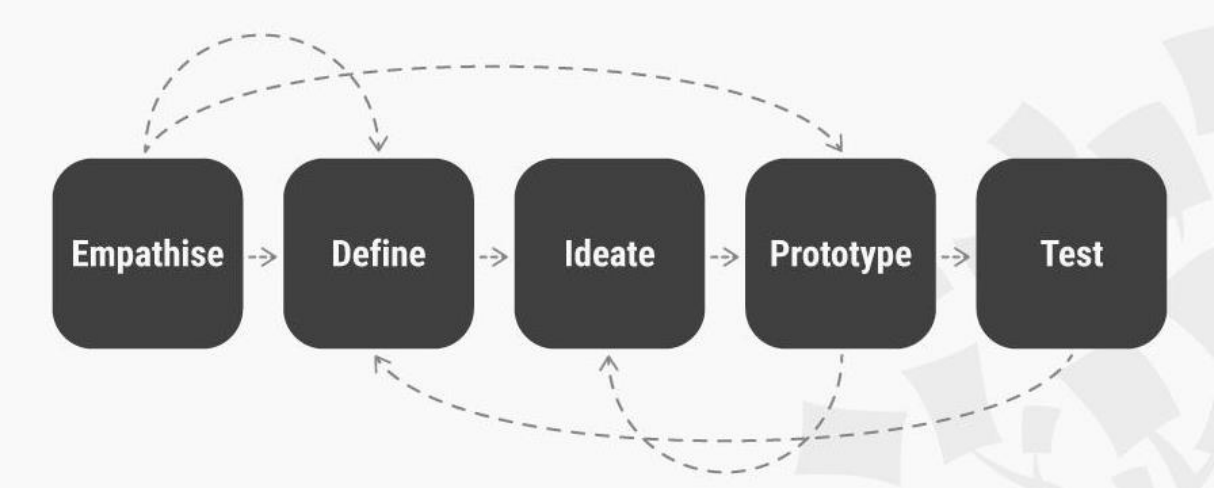

Figure 2 - Design Thinking stages (https://www.interaction-design.org/literature/article/design-thinking-a-quick-overview)

2.5.1. Empathize

The first step of DT process consists in gain and empathic understanding of the problem to solve. This entails consulting specialists to learn more about the topic at hand, as well as watching, interacting, and empathizing with people to understand their experiences and motivations, as well as immersing yourself in the physical surroundings to obtain a better personal grasp of the issues at hand. This phase is essential, because it allows design thinkers to lay aside their own worldview assumptions in order to acquire insight into consumer and their needs.

There are some methods used for empathizing (Mortensen, 2021):

- **Interviews:** individual, joint or both types of interviews can be done, allowing you to gain detailed personal insights and focus more on specific areas of information to guide the DT process.
- **Five Why's technique:** use this to explore the cause-and-effect relationships that generate a particular problem, asking why the causes and diving into each answer.
- **Assuming a Beginner's Mindset:** when making observations, we as design thinkers should constantly try to leave personal preconceptions and experiences at the door. Life experiences shape our assumptions, which we use to explain and make sense of the world around us. However, this very process has an impact on the ability to empathize with the individuals we witness.

2.5.2. Define

At the Define stage, the knowledge developed and received throughout the Empathize stage will be put together by being analyzed and synthesized to describe the fundamental challenges/problems identified so far. It is recommended to define a problem statement in a human-centered way, not as a personal desire, such as "We need to increase our food-product market share among young teenage girls by 5%", but rather as a goal, “Teenage girls need to eat nutritious food to thrive, be healthy and grow.”.

In this stage, it will be helpful that design thinkers manage to gather outstanding ideas for features, functionalities, and any other aspects that will allow them to solve problems. In this stage, it is normal to start to proceed to the next stage, Ideate, by asking questions that will help you seek for answers.

2.5.3. Ideate

Like the name indicates, this stage is where the design thinkers generate the ideas for solving the problems identified in the previous stage. These ideas should not be restricted in any way, they are all important, even “out of the box” ones, so it will be possible to discover innovative solutions with input from all participants.

There are some techniques that can be applied for this:

- **Brainstorm:** creative approach in which efforts are made to discover a solution to a specific problem by compiling a list of ideas given spontaneously by its participants.
- **SCAMPER**: acronym for *Substitute, Combine, Adapt, Modify, Put to another use, Eliminate* and *Reorganize,* forming a tool used to review and reformulate previously generated ideas, with the objective of creating new ones.
- **Worst possible idea:** team members actively seek the worst possible answers during ideation sessions. The "inverted" search method calms people down, enhances their confidence, and sparks their creativity, allowing them to study these ideas, question their preconceptions, and acquire insights into outstanding ideas.
- **Storytelling**: in simple words, the solution is explained in story format. This technique is very powerful because it allows to get insight into users, reaching them emotionally and building empathy.

2.5.4. Prototype

This fourth stage involves converting the ideas raised in the previous stage into reality, in which the team will create several low-cost, scaled-down versions of the product with aspects that could be part of the product. To test the prototypes, they must be shared between the team, the department, or groups outside the team.

This is an experimental phase with the goal of finding the best solution for each of the challenges highlighted in the previous three phases. The solutions/ideas are developed into prototypes, and one by one, they are analyzed and either approved, improved, and re-examined, or rejected based on user feedback. What this phase offers are a better understanding of constraints and issues, as well as how real users would behave, think, and feel while engaging with the finished product.

2.5.5. Test

Finally, the last stage refers to a testing phase, i.e., facing the prototype with reality, this being the end consumers. It is very important not to skip this phase, despite the rigorous internal testing of the prototype, it is not possible to know its effectiveness without going through this phase, as the customer will have to approve and give his opinion on what is good/bad for him and from there it can be done the necessary changes. Depending on the number of prototypes, only the best ones can be chosen to be tested with the customers.

Although this is the last phase, the DT process does not end here, as said before, this is an iterative process, in which the results obtained here are usually used and refined for other iterations, until there is a final solution.

2.5.6. The Non-Linear Nature of Design Thinking

Design Thinking is not rigid and linear process in which one stage apparently leads to the next, with a logical conclusion at the end of the user testing stage. In practice, it is performed in a more flexible and non-linear way. As a rule, each phase of the process is repeated iteratively and, in addition to each stage being able to occur simultaneously, it is also possible to go back without even reaching the end of the fifth phase. Therefore, the stages may not always be sequential (see Figure 3).

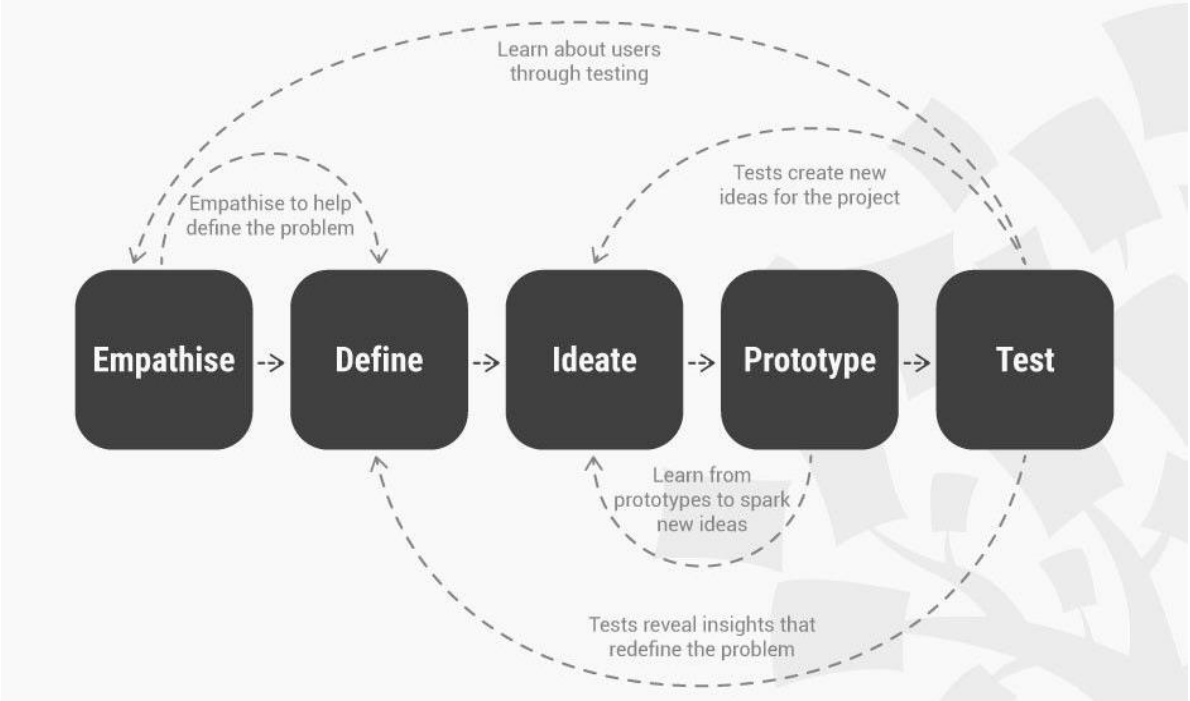

Figure 3 - Design Thinking Cycle (https://www.interaction-design.org/literature/article/stage-3-in-the-design-thinking-process-ideate)

2.6. Gamification

Gamification is growing over the last few years in popularity, and it is relatively recent concept that focuses on using gaming elements in non-gaming environments to engage audiences and inject fun into monotonous work while also providing motivational and cognitive advantages. This implies that, rather than producing immersive full-fledged games like "serious games," gamification aims to influence users' behavior and motivation through game-like experiences (Sardi et al., 2017).

Other beneficial aspects of gamification are the utilization of social networks to improve user engagement and involvement, helping the cognitive growth by stimulating the brain and encouraging information acquisition. It aids in the development of players' strategic abilities which improves their working memory, visual attention, and processing speed (Sardi et al., 2017).

The use of gamification in the digital healthcare business has sparked considerable attention. The disparity of access to healthcare resources, the lack of adherence to treatment, and the rise in healthcare expenditures all contributed to this rising interest. This domain has seen a rapid increase in the adoption of gamification. Several systematic studies have evaluated their usefulness in encouraging specific health behavior changes and in lowering a wide variety of symptoms due to their capacity to inspire, engage, and entertain. It was found that the health

areas that use this concept the most are the management of chronic diseases and physical activity, with most studies indicating that aspects of reward, feedback and socialization are the most used options (Sardi et al., 2017).

2.7. Related work

After thorough literature review, there is no solution to solve the problem of self-management and tele-rehabilitation of people diagnosed with 100% fibromyalgia. However, there is some previous work about telerehabilitation and self-management of people with other diagnoses.

Such an example is the research conducted to develop a **Web-Based and Mobile App to Support Physical Activity in Individuals with Rheumatoid Arthritis** (Revenäs et al., 2015), called tRAppen. In this case, it was employed a co-design strategy to collect data throughout numerous workshops, with the co-designers being participants from diverse fields (people diagnosed with the pathology, clinical physical therapist and researchers, an officer from the Swedish Rheumatism Association (SRA), and a designer).

The resulting solution was based on two preliminary frameworks, “My self-monitoring” and “My peer group”. The former has the goal of providing a way to plan, set goals and record physical activity (PA) and progress. The latter consists of building a small community for positive feedback and support from peers.

In detail, this application has the following features sorted by modules:

Recording: goal, planning, and self-monitoring of PA performance and health status
A calendar for recording of physical activities performed and planned.
Support the performance and recording of RA-specific physical tests and self-rate health tests.
Review set goals and physical activity performed on the welcome screen.
Support identification and recording of individual rewards**.**

Table 1- tRAppen recording module features

Visualization: feedback on personal and peers' performances and health status
Provide visualized feedback on physical activities performed in relation to physical fitness and health that are displayed as diagrams or bar chars.
A status indicator of the health and physical activity.
Show peer group members, name, pictures/avatars, and status in relation to the physical activity goal achievement and physical activity performed.
Visualize the next planned physical activity on the welcome screen.

Table 2- tRAppen visualization module features

System alerts: receive reminders or rewards/punishments from app
Reminders as text messages and emails based on the individuals.
System rewards, e.g., medallions and stars.
System punishments, e.g., send an angry face.

Table 3- tRAppen system alerts module features

Social interaction: give and receive encouragements and support from individuals with RA
Chat.
Send encouragements/likes.

Table 4- tRAppen social interaction module features

Facts and information: texts and links on up-to-date information about PA in RA
Present short tips on good physical activities in everyday life.
Present up to date information on physical activity.
Access to links related to physical activity in RA.
A library with short films on physical activity on different level.

Table 5- tRAppen facts and information module features

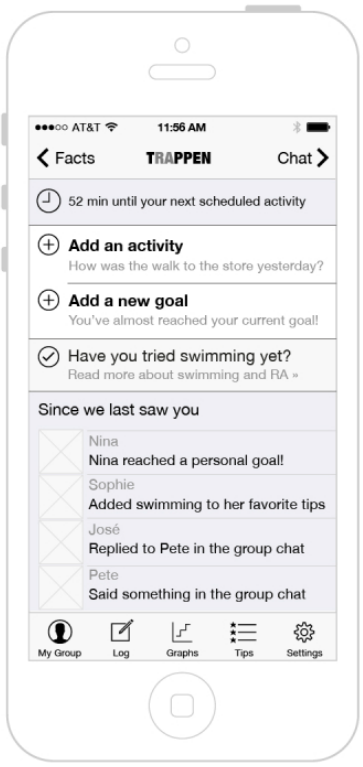

Figure 4 - Illustration of the welcome screen of the Support Physical Activity app (Revenäs et al., 2015)

With this work it was found that features enabling self-monitoring and peer support were very important for individuals with RA to self-manage and maintain physically active lifestyles and it should be included in future applications. Furthermore, it was suggested that in future applications should be included the concept of small communities of ten individuals to give guidance, encouragement, and assistance in finding answers to problems, the Arthritis Self-Management Program is based on small communities of patients moderated by a trained peer (Revenäs et al., 2015).

CareHand, is a mobile application for the treatment of rheumatological (osteoarthritis and arthritis) diseases of the hand and fingers. It provides several specific programs for each pathology, such as a series of exercises and personalized recommendations based on pathology and recovery time, as well as various functionalities that will allow the patient and linked healthcare professional to know how your performance is in the application and different variables related to your pain and functionality (Rodríguez-Sánchez-Laulhé et al., 2020). Figure 5 shows the main screen, the exercises screen and the progress screen of the application developed.

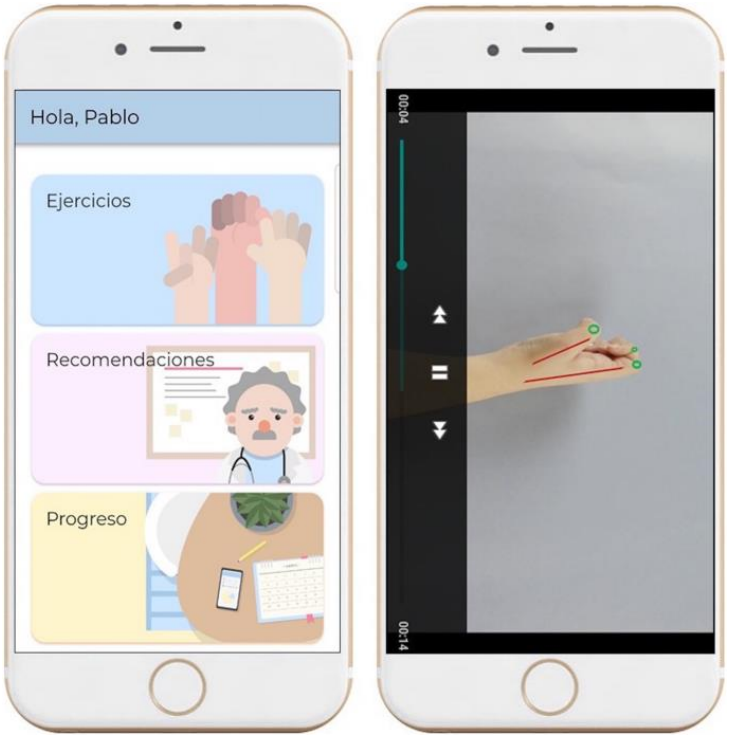

Figure 5 - CareHand Application (Rodríguez-Sánchez-Laulhé et al., 2020)

This application allows a new way to treat and monitor people with other chronic rheumatic diseases such as osteoarthritis, facilitating communication between patient and therapist. This can have a double impact on health systems: by reducing the costs with presential consultations, patient travel and absence from work; and can also improve the quality of public health service that is offered.

The research team of **TEAMS (Tele-Exercise and Multiple Sclerosis), a Tailored Telerehabilitation mHealth App**, created a simple therapeutic workout bundle that that included a tablet and a floor stand that could be adjusted to accommodate various exercise positions. The resulting app contained a password-protected feature that enables therapists to swiftly modify the workout videos to match the functional demands of the individual via six distinct levels of TEAMS exercise adaptations. Most workouts provided variations to enhance or reduce the level of difficulty within each level. Depending on their preferences, participants might undertake the conventional exercises or a customized version (Thirumalai et al., 2018). This project had the involvement of people connected to exercise as well as to technology. By using the concept of user-centered design, participants were included at various stages of the development process, which proved to be very important. This was verified through usability tests with good results (easy to use). Figure 6 and Figure 7 show how the application could be used.

Figure 6 - TEAMS, utilization example (Thirumalai et al., 2018)

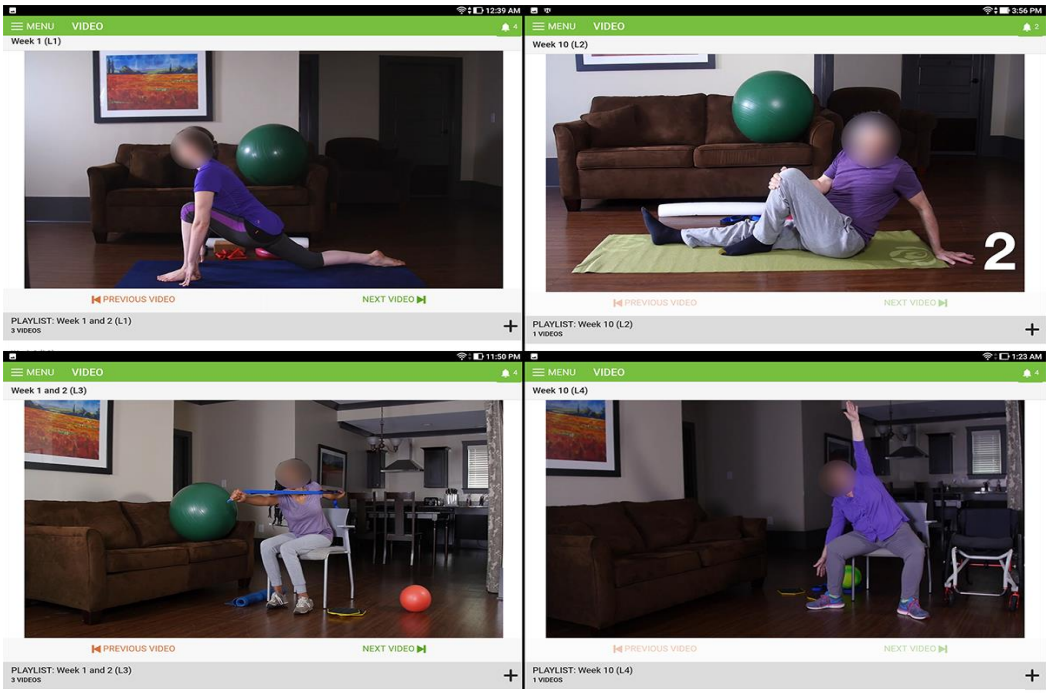

Figure 7 - TEAMS, Application usage (Thirumalai et al., 2018)

Chapter 3

Research Process

This chapter describes all the research work that was done with the people involved in the project in order to gather more detailed information to design a solution to solve the problem described in section 1.2 following the DT methodology.

3.1. Research Methodology

Considering that this type of work is very focused on research, and that the main users (persons diagnosed with fibromyalgia) are a fundamental key to a successful project, it was soon agreed that an approach centered on the user would be necessary. As some of the team members had already worked with a methodology based on the Design Thinking process with very positive results, which would fit perfectly to this type of work, the team decided to use it.

As mentioned in section 2.6, this methodology encompasses five phases that were mapped to a set of actions in the context of this work. All these actions are based on a means of communication/discussion with users, by conducting the use of workshops in all phases of this methodology. These workshops consisted of the participation of the members of the research team with a background in physical therapy and technology, with a set of people diagnosed with fibromyalgia, physical therapists and people associated with organizations that support people with this pathology. To avoid any discrepancies between the perspective of people treating the disease and people who have it, the workshops were divided into two types, one for people with the disease and another for physical therapists, except for the last three workshops where health researchers attended the last workshop. That is why in a short period of time there were always two/tree workshops, as shown in Figure 8.

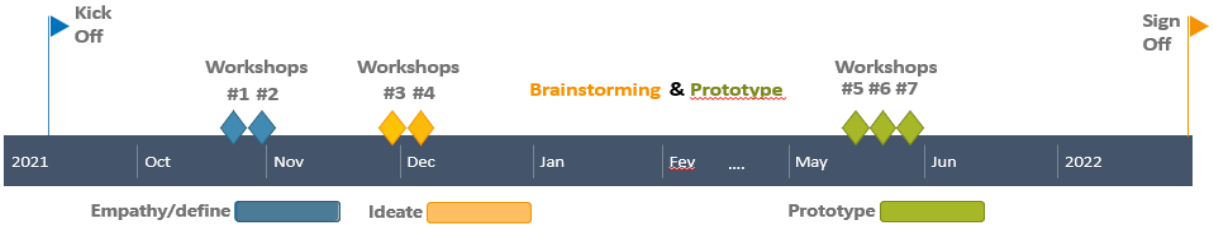

Figure 8 - Workshops timeline

Before these workshops were held, the health team had already conducted a focus group study that identified some critical points (see Table 6) regarding the problem identified in section 1.2 and possible concerns that might exist in the creation of a digital solution to overcome this problem. It was through these points that the following workshops were prepared in order to raise further discussion about the issues, thus detailing them.

Critical points identified
How to make it easier to integrate exercise into the daily routine?
How to ensure good integration of the family in the rehabilitation process and how to maintain privacy in the sessions with them?
How can technological barriers be overcome?
Fear of performing exercises incorrectly and not being properly corrected by the health professional.
Decreased motivation and adherence due to the online model.
Difficulty in establishing the therapeutic relationship and group dynamics due to the remote session model.
How to ensure the therapeutic relationship?
Difficulty in the initial evaluation by the physical therapist since it integrates an objective/physical evaluation.
What strategies can be used to minimize the impossibility of the therapeutic touch?
Need to personalize interventions for each participant.
Need for communication between physical therapist and patient.

Table 6 - Digital solution critical points

Since the first two phases, Empathy and Define are very interconnected, they were conducted simultaneously, through two workshops that took place at the end of October 2021 with about 10 people each. The main objective was to gain trust between all the people

involved, so that they felt at ease and were not ashamed or afraid to speak out. In this way they would be able to indicate their main needs and problems, so that in the end there would be a better understanding by the whole team, that allowed grouping, analyzing and synthesizing the set of key problems in a human-centered way. Although it was not planned for these two workshops to enter into the ideation phase, there were already some ideas emerging to solve some identified problems, which is perfectly normal and expected since the DT is flexible and foresees this type of situations.

Regarding phase 3, "Ideate", two more workshops were held in late November and early December 2021 with the same people from the previous workshops in order to generate ideas to solve the problems identified. These problems were presented in a practical and understandable way so that people could relate to them in order to express solutions that would make sense to them and help mitigate or eliminate these problems.

Before the last three workshops, some brainstorming sessions were held where the solution was conceptualized according to all the ideas obtained in the previous sessions. Then the development of all these parts was started by building the prototypes to be shown in the next workshops. The initial intention was that all the people involved so far would be able to help creating these prototypes, but as computer literacy was low for using software programs and the pandemic made it impossible for us to get people together to do this work face to face, e.g., to create paper prototypes, this work fell more on the research team. Basically, this part of the research belonged to the idealization/prototyping phase of the project, where it was necessary to gather all the ideas generated by the previous workshops, always thinking how they would make sense together, bringing them to life by creating the initial prototypes.

Finally, after the prototypes were created, it was time to present them at the workshops 5, 6 and 7 at the end of May. These prototypes were intended to allow a better perception of how the solution was created and of how the key points that they identified had been transformed into functionalities in the solution. In these sessions they could give their opinion, if they agreed or not, if they would change something, if something was not as clear as expected, thus also being involved in the "Prototyping" phase.

After these prototypes were validated by the team, the development of the solution began, which will be explored in chapter 4 of this document. Chapter 5 presents the final tests that were performed to understand what were the successful points in the solution and the ones that need to be improved.

3.2. Initial Workshops

As previously mentioned, there was a total of seven workshops. All of them were conducted remotely using the Zoom videoconferencing application, with each one corresponding to one or more phases of the methodology presented above in section 3.1 with a specific theme. These workshops had an average duration of ninety minutes (90 min). In this section only the four initial workshops will be presented, with the last three regarding prototyping being explained in section 3.4.

These initial workshops started with a presentation by all of the stakeholders for about fifteen minutes with the goal of getting everyone talking to feel more comfortable, as well as checking if there were any connection/communication issues.

A scenario was then presented which described a key issue/problem that had been identified in the first phase of the project for which a solution was sought. In each scenario, a persona of someone diagnosed with fibromyalgia, and with certain difficulties that the participants were supposed to solve, was described. This allowed to better identify the problem and have the people relate to it, thus making a better use of the session time. After the presentation of the scenario, the questions related to it were presented and the debate between all the participants was initiated.

Finally, the workshop was concluded by thanking everyone for their participation and availability, while allowing a moment to ask any last questions or present any relevant information.

As previously stated, prior to these workshops, a set of problems and their priorities were identified by the physical therapy research team, which served as a guide for the construction of the scripts for the upcoming workshops. This information can be seen in Tables 7 to 10, divided by the topics to be discussed in each of the four workshops. The characterization of the person, their context, needs, and the insight acquired at that time is presented in each of these tables.

Topics used to prepare the workshop 1

User	Needs	Insight
Person diagnosed with fibromyalgia undergoing telerehabilitation for the first time.	Strategies that promote the therapeutic relationship and group dynamics in an online format.	In presential physical therapy sessions, the therapeutic relationship (physical therapist -patient) develops a lot through touch and empathy. Many people find it more difficult to establish relationships at a distance, in this case, the therapeutic relationship and the relationship between the various project participants throughout the sessions and outside of them (group dynamics).
Person diagnosed with fibromyalgia.	Need (if any) for a mixed intervention model.	Some people believe that intervention in a mixed model (presential and online sessions) can allow for a better therapeutic relationship and group dynamics and greater confidence in the intervention.

Table 7 – Topics used to prepare the workshop 1

Topics used to prepare the workshop 2

User	Needs	Insight
Person diagnosed with fibromyalgia with little confidence in an online intervention.	Strategies that promote confidence in the intervention and performance of physical exercise in an online format.	Usually, the physical therapy sessions are in person. When transported to an online format, confidence in the outcome of the intervention may be lower due to lack of knowledge of the model and the fear that the physical therapist will not be able to see/detect, for example, a poorly done exercise or an incorrect posture.
Person diagnosed with fibromyalgia who has already undergone physical therapy sessions in person (and therefore has doubts that the online intervention is equally effective).	Strategies to build confidence in the remote intervention by a physical therapist and the initial assessment.	With a previous experience of presential physical therapy sessions, it will be inevitable that there will be a comparison between the two models. Once you get good results in person, you need to build confidence that you will also get good results and be rigorously evaluated online.
Physical therapist who will implement the project online (tele-rehabilitation).	Strategies to Ensure Proper and Accurate Participant Initial Assessment in Online Format.	The assessment of physical therapists is, as a rule, done in person and using contact and therapeutic touch. In an online format, the strategies will necessarily have to be readjusted - some physical therapists may feel insecure about the clinical evaluation in this format.
Person diagnosed with fibromyalgia.	Need for individualization and personalization of their physical therapy intervention.	Each participant, despite having a common pathology (fibromyalgia), has different symptoms and, therefore, different needs at each stage. There needs to be strategies that allow for the personalization of each participant's treatment whenever necessary.

Table 8- Topics used to prepare the workshop 2

Topics used to prepare the workshop 3

User	Needs	Insight
Person diagnosed with fibromyalgia with family members in the same room.	Privacy throughout the physical therapy sessions and the family members' understanding of the disease.	Sensitive topics can be addressed throughout the sessions and some participants may not feel comfortable with the presence of family members. On the other hand, it will be important to include family members in some sessions for a better understanding of the disease and its impact.
Participant in a telerehabilitation model for people with fibromyalgia.	Explore the most appropriate way to implement an online project for the assessment and treatment of people with fibromyalgia among the various technological options available.	There are different types of applications (native mobile app or web app). Each option has its advantages and disadvantages for the user and for the team implementing the project.
Participant in a telerehabilitation model for the assessment and treatment of people with fibromyalgia.	Customizing the individual area of each participant.	For each participant to feel integrated into the model, it may be important and motivating to customize their area, such as creating an avatar and modifying their profile information.
Participant in a telerehabilitation model. for the assessment and treatment of people with fibromyalgia.	Use of reminders, points, and trophies system.	It can be motivating and make the intervention more immersive, using a reminder system for some tasks, as well as points, and trophies system throughout the sessions.

Table 9- Topics used to prepare the workshop 3

Topics used to prepare the workshop 4

User	Needs	Insight
Person diagnosed with fibromyalgia.	Strategies and motivation for integrating exercise into everyday life.	The integration of physical exercise into everyday life facilitates condition management, reducing pain and helping to manage symptoms. However, for a condition whose main symptom is fatigue – integrating exercise into everyday life is a difficulty.
Person diagnosed with fibromyalgia with low motivation for an online intervention.	Promotion of motivation and adhesion to the project	With the lack of knowledge about online intervention projects, adherence to the project may be lower. Lack of time in everyday life, tiredness and other symptoms of fibromyalgia make it difficult to motivate and adhere to the project.
Physical therapist who will implement the project online (tele-rehabilitation)	Communication with participants and exploring the most viable communication channels.	In a presential format, communication takes place in a more natural way. In online format, it is necessary to explore the most effective communication channels so that the therapeutic relationship is maintained even outside the sessions, in case any situation/question/problem arises.

Table 10- Topics used to prepare the workshop 4

Below is a detail of how each workshop was conducted with detailed information on the theme, scenario and what was learned.

3.2.1. Workshop 1

This was the first of four workshops that were held. Both this workshop and the next one played a key role in establishing a relationship with the participants. The main subject of this workshop was the relationship between the physical therapist and the group dynamics in an online format and whether there was a need for a mixed model, i.e., online, and presential.

The scenario presented was as follows, “Celia is 50 years old, divorced, and was diagnosed with fibromyalgia 5 years ago. She teaches physical education in an elementary school in the outskirts of Coimbra. As a teacher, she feels increasingly unmotivated, at times feeling that her profession is the reason for the exacerbated symptoms since it is necessary to exemplify the same exercises and movements countless times. She has a small vegetable garden at home and likes to spend the evenings there, but sometimes the fatigue becomes extreme and prevents her from taking care of the land.

When she was initially diagnosed, it was recommended that she begin physical therapy sessions, with a focus on exercise. With these in-person sessions, Celia felt improvements in her daily life, especially regarding fatigue.

When she discovered an online project for people with fibromyalgia, she became curious and motivated to join. However, besides questioning herself about the initial assessment and the effectiveness of the treatment, she also questioned herself about the construction of the therapeutic relationship and the group dynamics. She thought that both parties would lose out in an online model, since it is more difficult to establish relationships at a distance. She compared the situation with her profession, how could she build a good teacher-student empathetic relationship if her classes were online?".

In order to promote discussion a set of questions were asked (see **Table 11**).

Question number	Description
Q1.	Which strategies do you think are appropriate to fight against the prejudice in the therapeutic relationship in an online format? In other words, what can be done by both parties to reduce this prejudice in the physical therapist -participant relationship?
Q2.	What moments could exist, in group and out of group, to nurture the therapeutic relationship?
Q3.	Would it be important to have an initial presential moment between physical therapist-pacient, in addition to the initial assessment, to establish objectives and foster confidence in the intervention?
Q4.	In what ways can we build and nurture the online group dynamic?
Q5.	What moments do you consider crucial to foster group dynamics, both in and out of class?

Table 11 - Questions discussed at Workshop 1

Through the responses of the various workshop participants, it became clear that the therapeutic relationship is very important, and there are some concerns. The biggest is the lack of closeness between therapist and patient, since it is through this that the mutual trust necessary for better results is developed. In order to mitigate this lack of proximity in a digital solution, it was proposed an immediate and continuous contact through a communication channel, such as SMS, email, or online chat. Regarding group interventions, it was mentioned that the physical therapist's competence is very important to promote and encourage the people's participation in the groups, and that they need to have an active role in demonstrating how the exercises are performed correctly.

Another relevant point was the acceptability of online interventions. This can vary greatly between people, with some not having the adequate physical space, or the necessary equipment,

while others may just be adverse to change in the first phase. In this case there is a flexibility to introduce presential sessions.

To summarize, communication is very important, either to have a greater proximity between patient and therapist, or even in relation to the motivation in promoting physical exercise; in addition, there may be some resistance to online interventions and a hybrid solution, i.e., the possibility of both presential and online interventions, should be considered.

3.2.2. Workshop 2

As seen earlier, this workshop focused on strategies to promote trust, performance, and accuracy of physical therapists' interventions in an online format, as well as the personalization and individualization aspects of these interventions.

The scenario presented was “Mariana Bento is 42 years old and married. She is a nurse by profession. She lives in Castelo Branco and has a 7-year-old son. She was diagnosed with fibromyalgia 10 years ago and since then has been on her path of acceptance and learning. At home, she has full support from her husband, parents, and in-laws, allowing Mariana to have time for herself. Since she was diagnosed, Mariana has sought the help of physical therapists to learn how to better deal with the condition and to minimize its impact on her daily life. She always performed physical therapy sessions, as it was close to her home, either in the clinic or in a garden. All the sessions were done individually, and Mariana felt very much that the whole process was important and that she is now able to better manage the situation on her own.
Her physical therapist invited her to participate in a project for people with fibromyalgia interventions in a group and exclusively online. Mariana welcomed and saw the group as a great asset in the project. However, after agreeing to be part of the project, she wondered about the online interventions. In person, the physical therapist corrected the incorrect postures, and she did not know if she would feel the same confidence in the online intervention. Would the interventions be the same for all participants? How could the physical therapist ensure the individual needs of each participant throughout all the sessions? Regarding the assessment of her needs, she began to wonder how it would be done since she had already done it once in person. How could the physical therapist make up for the lack of therapeutic touch in this first approach?”.

During the session some of the following questions were presented and discussed:

Question number	Description
Q1.	How can personalization of interventions be ensured?
Q2.	What strategies can be used to ensure that individual needs are met?
Q3.	How can we ensure an effective initial assessment in an online format?
Q4.	What strategies might be used to minimize the lack of the therapeutic touch?
Q5.	How can this difficulty be overcome? Would it be feasible to have an initial presential session?
Q6.	How can we ensure that the exercise is being done properly?
Q7.	What is your level of confidence in this type of intervention, regarding safety and efficacy
Q8.	What strategies could be used to increase the level of confidence?

Table 12 – Questions discussed at Workshop 2

In this workshop, it became apparent that whether the intervention is in person or online, there needs to be a prior assessment of the patient's personal needs, such as goals, difficulties, and physical testing. If the interventions are to be done online, it is also necessary to know what equipment is available, the space available, and level of privacy in the place where the intervention will take place, so that adaptations can be made or to inform in advance about the resources needed. It is important to have a continuous evaluation/reassessment at each session in order to guide the necessary adaptations to match the patient's current state, since this clinical condition is characterized by fluctuating symptoms. Confidence in the intervention was a much-discussed point where people argue that the efficacy and safety of telerehabilitation will not be in question because it is a remote intervention, but the main challenge will be to motivate the patient. According to the people there are ways to mitigate this lack of trust in this type of intervention, either through sensors that offer greater safety in the execution of the exercises by providing the physical therapist with information about how the patient is performing the exercise, or through video call allowing the physical therapist to identify the need for adjustments through visual observation, when it is not captured by the sensors, or through the existence of verbal feedback during the execution of the exercises.

3.2.3. Workshop 3

This workshop focused in discussing possible solutions or technological ideas for a set of problems. Beforehand, since the purpose was a little different than the previous workshops, the team decided that the use of the MURAL[1] platform would be beneficial, as it would allow better interaction between all participants. Before starting the workshop, the team created a mural with the questions that were being asked during the meeting. During the workshop, the participants would then add post-it notes with the ideas that came to mind at the time. The idea would not be to present a very long answer, but rather words to be explored together later.

The scenario presented in this workshop intends to explore the most appropriate way to implement the project considering the various technological options available, the customization of each participant's individual area, and explore the use of reminders, points, and trophies systems within the project model. The scenario was defined as it follows: “Maria, a 40 year-old educational assistant, was diagnosed with fibromyalgia 5 years ago. Maria was invited to participate and make some contributions in the co-creation of a project for the assessment and treatment of people with fibromyalgia, in an online format”.

During the session some of the questions shown in from Table 13 to Table 16, were presented and debated. These questions are divided into "modules", with each one was being shortly presented to the participants of the workshop.

Module 1 – Data model

Considering the creation of the data model, and that it would be used by health professionals and users, these were the first questions that were asked.

[1] https://www.mural.co/

Question number	Description
Q1.	What kind of records/information would it be important to be able to store?
Q2.	For Health Professionals – What kind of information would be relevant to introduce about users, and the sessions themselves, so that they can be recorded and accessed again in the following sessions?
Q3.	For users – If you could put some information about your evolution/monitoring throughout the day/sessions, what information would you like to introduce? (e.g., hours of sleep, general tiredness, level of pain, etc.)

Table 13 - Questions discussed at Workshop 3, Data model module

With the help of this questions some ideas were proposed, mainly related to sessions and symptom monitoring, such as:

- Possibility to see when the next session will be and what tasks the patient will have to do autonomously until then, through a work schedule.
- Possibility to record clinical indicators that are relevant in the context of fibromyalgia, in particular functional progression, using patient-reported outcome measures.
- Registration of symptoms to be able to check their evolution, for example the level of pain at a certain moment, or performing an activity with the help of a body chart, or the level of pain and fatigue during a session.
- Registration of factors that trigger "crisis"/flare-up/aggravation of symptoms, in order to focus on their prevention.
- Record aspects related to the autonomous performance of physical exercise, such as difficulties, feedback, but also positive aspects (mood, leisure activity) to avoid that the person is focused on recording only negative aspects.
- Objectives and procedures performed in the session itself, i.e., covered educational content, exercises performed (number of sets and repetitions), and user response.

Module 2 – Customize account

After the discussion on the type of information to be recorded, the question arises as to where to record it and whether the ability to personalize it makes sense.

Question number	Description
Q4.	How can we customize our “account”? What kind of information makes sense to customize?
Q5.	Would the creation of an avatar and the possibility to change the app colors be beneficial?
Q6.	Does it make sense to make some information available to other users and physical therapists?

Table 14 - Questions discussed at Workshop 3, Customize account module

It was possible to verify some very interesting ideas through these questions. Starting with an Avatar, it was indicated that it would be important for it to exist, containing information about the person (previous history, date of the first of symptoms, date of the diagnosis, treatments carried out, health professionals who are following the person, hobbies and interests, professional occupation, family context) and that it could help personalize interventions and predict episodes of worsening symptoms. Also related to this topic, it was also suggested an option to share some information (publicly to users of the platform) in order to promote the concept of community, as well as an option to export information from the avatar, for example a generated report, facilitating the interaction in a medical consultation. In addition to this, it was also suggested that emotions could be recorded over time to be able to identify any correlations between the record of symptoms and emotions at the same time, through a graphical representation that would then allow this analysis over time. These graphical representations should be present in various parts of the solution in order to make it easier to visualize, with the option to choose colors for these charts.

The questions related to the next two modules were not asked due to the session time coming to an end but were discussed indirectly in the following workshops.

Module 3 - Motivation

Considering that in the intervention program there would not only be group exercise sessions but also autonomous exercise, we tried to understand people's motivation for this type of exercise.

Question number	Description
Q7.	Is it important to have some feedback on individual progression?
Q8.	Would a scoring and trophies system be motivating? What kind of actions could be scored?
Q9.	Does an individual, as well as a group progress/trophy system, make sense, including, for example, group challenges? (e.g., imagining there would be 10 participants, the group would have to travel 30 km for a week – each participant travels 3 km to complete the challenge)?

Table 15 - Questions discussed at Workshop 3, Motivation module

Module 4 – Project implementation

In addition to the previous questions, the implementation format of the project emerged, where we tried to understand what would be the most viable.

Question number	Description
Q10.	What are the advantages and disadvantages of a mobile application?
Q11.	What kind of records/information would it be important to be able to record?

Table 16 - Questions discussed at Workshop 3, Project implementation module

3.2.4. Workshop 4

This workshop had the same purpose as the previous one, to debate technological solutions/ideas for a set of questions asked during the session. However, there were some differences when compared to the previous one, such as the debated scenario, some of the consequent questions, as well as the participants.

The scenario of this workshop aimed to explore strategies for integrating physical exercise into the daily routine, as well as to promote motivation and adherence to the project. The presented scenario was the following: “Maria Fernandes is 52 years old and unemployed. She was diagnosed with fibromyalgia ten years ago, she is married and has two children. She lives in Lisbon. She was invited to participate in a project to assess and treat people with fibromyalgia in an online format. Maria had used physical therapy before where she got good results and felt better with her condition. However, with the lack of time and all her daily tasks, she ended up getting unmotivated and stopped attending sessions.

As in the previous workshop, the questions shown from Table 17 to Table 18 were presented and debated, and they were also divided into different "modules".

Module 1 - Project adherence

This module aims to try to understand in which ways people adhere to the project more easily and consistently, considering that due to their daily routine their motivation is not the greatest strength.

Question number	Description
Q1.	What early project strategies allow people to adhere to the project more easily? (e.g., individual sessions, discussion and sharing experiences in groups)
Q2.	What are the best strategies to facilitate the integration of physical exercise into your daily routine?

Table 17 - Questions discussed at Workshop 4, Project adherence module

To ensure that the change in the way the sessions are carried out does not change drastically from one moment to another, it was suggested that the solution should be flexible (as previously mentioned), because there are people who initially prefer to have their sessions in person and then change to online, or in a first phase they have individual sessions and, when they feel more comfortable, they can do some group sessions. In addition, a point mentioned that promotes adhesion to the project was the additional flexibility in terms of scheduling, because both the physical therapist and the patient will not be limited to the schedules of the places where they usually do their sessions, or the distance between their home/work and the session location, allowing them to have a wider set of possible schedules. Overall, everyone indicated that just the existence of the solution itself was motivating.

Module 2 - Motivation

Sometimes when the symptoms of the pathology are more aggravated, or the person's daily life is busier, motivation usually drops as well. In this module, an attempt was made to understand how to mitigate this lack of motivation.

Question number	Description
Q3.	Which adaptations should be used to motivate participants over time?
Q4.	Will it be important to have any feedback on individual progression?
Q5.	Would a scoring and trophies system be motivating? What kind of actions will be scored?
Q6.	Does an individual as well as a group progress/trophy system make sense, including, for example, group challenges? (eg, imagining there would be 10 participants, the group would have to travel 30 km during a week - Each participant travels 3 km to complete the challenge)?

Table 18 - Questions discussed at Workshop 3, motivation module

This module had a more engaging discussion between the various people on the team, which led to many ideas, as motivation is a crucial point in using this solution. First it was indicated that the social component was very important, where having someone exercise helps a lot to motivate them. The first suggestion was the creation of a buddy system, where people could be placed into groups, preferably with the same needs/interests and geographically close, so that they could exercise together, for example by walking.

Another idea that was very well received was the creation of group challenges, in which a goal was set, and all members of the group would have to help to achieve that goal, for example walking a certain amount of meters during a week/month. Besides promoting physical exercise, it also stimulates competition, which if well managed could bring benefits.

Another possibility is points, trophies and rewards systems, as this would allow the person to keep track of their situation and be indirectly motivated to continue to engage in exercise as they feel the positive results, e.g., there is a reward for the participant of the week who achieved the most goals set with their physical therapist, with the possibility to share these results with other users.

Module 3 - Communication

The idea of this module was to find out what would be the most practical and feasible way to communicate with the physical therapist.

Question number	Description
Q7.	What are the most viable channels for this communication? (e.g., through the project application itself, email, WhatsApp...)

Table 19 - Questions discussed at Workshop 4, Communication module

From the beginning it was clear that communication is a key point in the project, where the relationship between patient and physical therapist had to be close and trustworthy, so people suggested the creation of a chat on the platform that would allow private communication with the physical therapist.

Module 4 - Project implementation

To try and understand how the project should be developed and on what devices it would be used, the following questions were asked.

Question number	Description
Q8.	What are the advantages and disadvantages of a mobile application?
Q9.	What are the advantages and disadvantages of desktop web app?

Table 20 - Questions discussed at Workshop 4, Project implementation module

Regarding this topic there was not a great consensus, with people indicating advantages and disadvantages for both a mobile or web application-based solution. It was mentioned that on one hand, having a multiplicity of applications in their smartphones can be a demotivating and tiring factor, especially if they constantly receive reminders/notifications about their illnesses. Besides, not all people can have a smartphone that allows them to make a video call with an acceptable quality, but on the other hand mobile applications make access easier compared to the computer, since they allow to work in a more versatile way. On the physical therapists' side, since they will have a more management role of their patients, it may be more practical to use a web application.

3.3. Brainstorming

Based on the workshops explained above, a brainstorming session was held in order to identify the problems and possible solutions coming from the ideas generated by the whole team. Moreover, the team also created a set of prototypes according to these proposed solutions. Early on, two main agents of this solution were identified: the physical therapists (see Figure 9); and the patient diagnosed with fibromyalgia (see Figure 14). Each of them has different needs when using this solution.

3.3.1. Physical therapist brainstorming

The focus of this brainstorming, along with the subsequent prototyping and development, was on the patients with fibromyalgia diagnosis. They were considered as the number one priority by the project team. Despite this, it was also discussed and identified what

functionalities could be part of the solution for the physical therapists, with special attention to patient management, with the following main components.

Communication

Communication between patient and physical therapist is very important, whether to clarify doubts, motivate, or even schedule your sessions. Therefore, the use of chat and agenda was considered.

Management

This aspect is the most critical for physical therapists because they need to be able to manage their patients, have access to their personal information, their evaluations and check their progress. The sessions are also very relevant since they need to have a global and detailed view of the set of sessions performed by each patient and what exercises were done so far.

Holding sessions

The delivery of the sessions was an aspect that was much discussed in the workshops. There were questions about how the sessions could be carried out remotely. The main idea was to make the sessions available through video call and somehow use sensors to more easily identify the incorrect performance of exercises, but there is also the possibility of the sessions being held in person, where the solution will only be used to describe what was done during the session. In a first phase, it was decided that the use of sensors would not make much sense due to the fact that people would have to acquire them and know how to work with them autonomously, so it was proposed to only work on this component as part of future developments.

Community

It was mentioned that the community concept could be very interesting, where challenges and group sessions could be organized by the physical therapist while taking into consideration the profile of each patient in order to increase the patients' sense of belonging.

There was also a prioritization of these components, where the team saw all these as a priority except for the community, which could take a back seat.

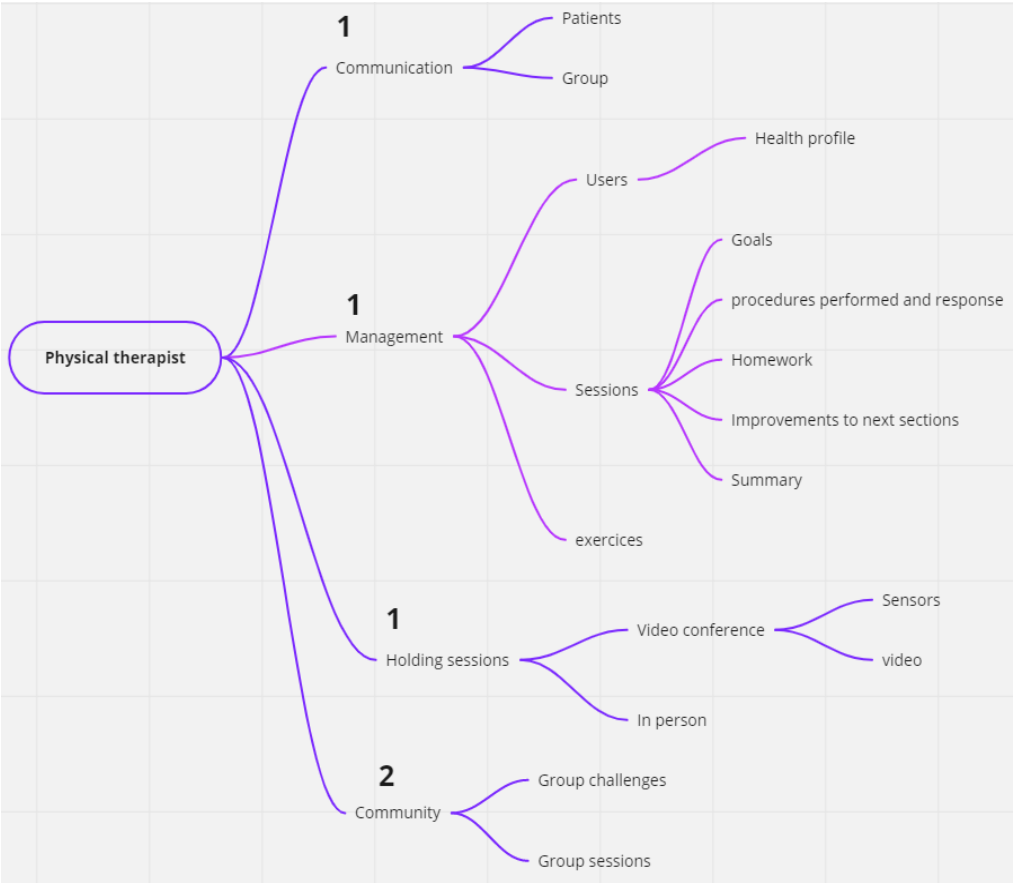

Figure 9 - Physical therapist brainstorming

3.3.2. Patient brainstorming

Regarding the patients, the set of ideas was a little larger, considering that they are the main focus of this solution. Besides the contacting with the physical therapist during the respective sessions, the self-management of the condition is also very important. Many of the components identified match those of the physical therapist, as the solution has its focus on their relationship and joint use.

Motivation

People with this diagnosis are sometimes demotivated due to the condition and the effects that the pathology brings to their lives, so it was considered to integrate gamification and challenges into the platform in order to help users engage into exercise. To achieve this, it was thought to have a progressive bar that will fill as the person performs their sessions, with the goal of attending all of them and having the full bar at the end of the month. In addition, it was conceived the existence of group challenges with the objective of walking a certain number of meters during the current month, being able to visualize the meters of each member of the group in order to promote competition. Finally, it was suggested that there should be a list of

tips related to the pathology, so that people can better understand it. The prototype interfaces for these ideas can be seen in Figure 10.

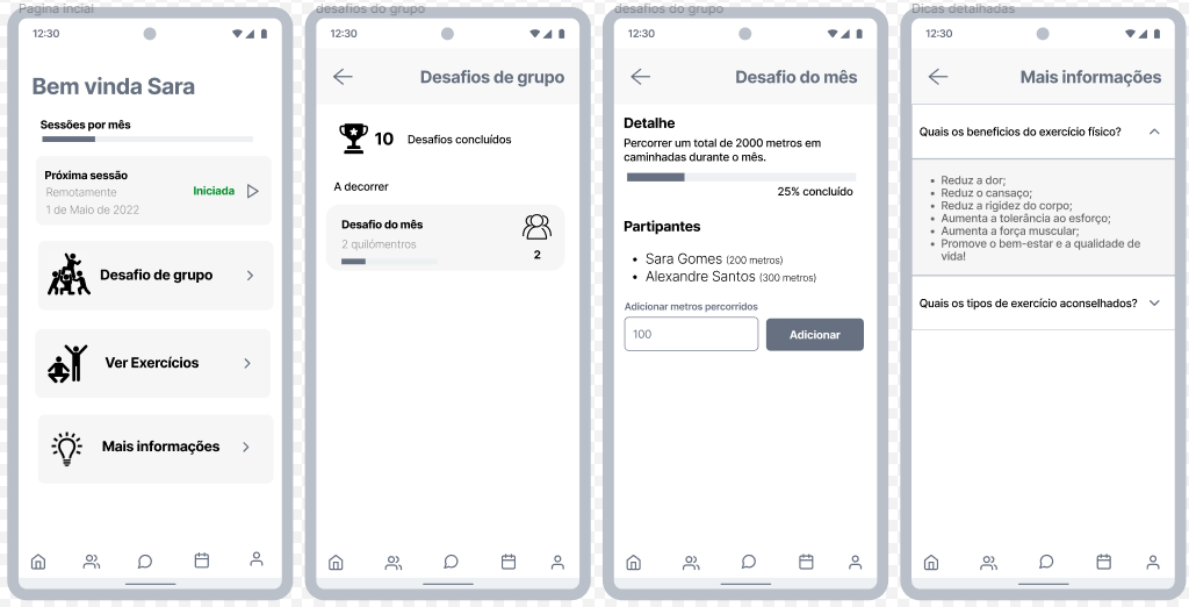

Figure 10 - Prototypes related to the motivational component

Community

The sense of belonging was another aspect discussed in the workshops. It was suggested that each person could have an avatar with information defined by them while also enabling the existence of a friendship concept where people would connect to each other so that they could share elements such as achievements, experiences, and doubts through a feed. Although this is an important point, it was decided that it could be developed in a future version of the solution, because it was not seen as a priority component by the whole team and it could be indirectly included in functionalities of other components, such as the group challenges for example.

Communication

As with the physical therapists, it is necessary to have a communication mechanism, not only between patients and physical therapists, but also with other patients. Since the buddy system is not a priority, it was thought about the possibility of talking through the system with the colleagues in the challenge group, so that they can organize the activities together thus promoting community. Therefore, it was considered to integrate a chat system into the solution so that it would not be necessary to communicate through a third-party system. In addition, another way to communicate more indirectly would be through the patient's agenda, where scheduled sessions would be available for consultation. The prototype of these ideas can be seen in Figure 11.

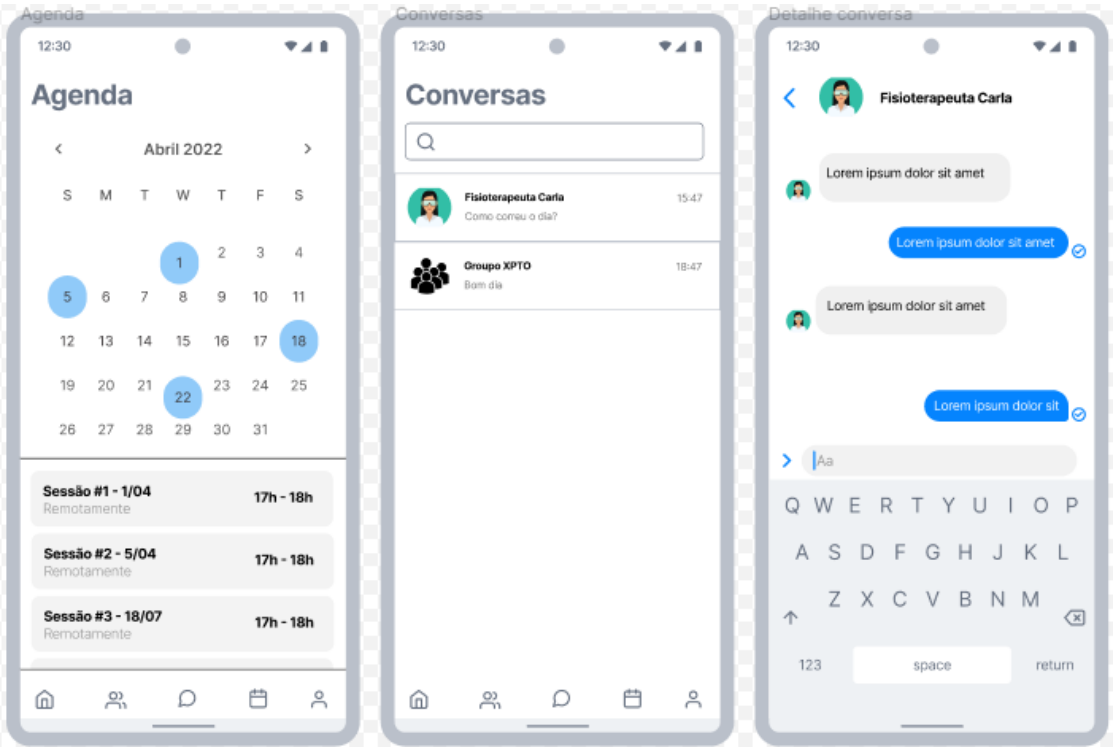

Figure 11 - Prototypes related to the communication component

Sessions

This is one of the main components of the solution, where one of the most critical points is the flexibility in the type of sessions that can be conducted within the platform. Therefore, 3 distinct types of sessions were identified: presential, remote, or individual. In the autonomous sessions, the aim is to provide the patients a set of exercises to be done at their own pace, without the help of the physical therapist. In both presential and remote sessions, the exercise history will be stored for future reference. The main difference between these two types is that remote sessions will be conducted via video call through the application. Exercises need to provide detailed information so that participants can perform them autonomously, e.g., the number of repetitions and sets, rest time, and a textual and visual explanation. Moreover, it was considered that it would be useful to include mechanisms to evaluate the sessions. For instance, a set of questions would be asked to understand the evolution of some indicators such as fatigue, pain, and heart rate. In addition, it was also idealized that observations about the session could be recorded so that the patient has information about what to improve. The prototype interfaces for these ideas can be seen in Figure 12.

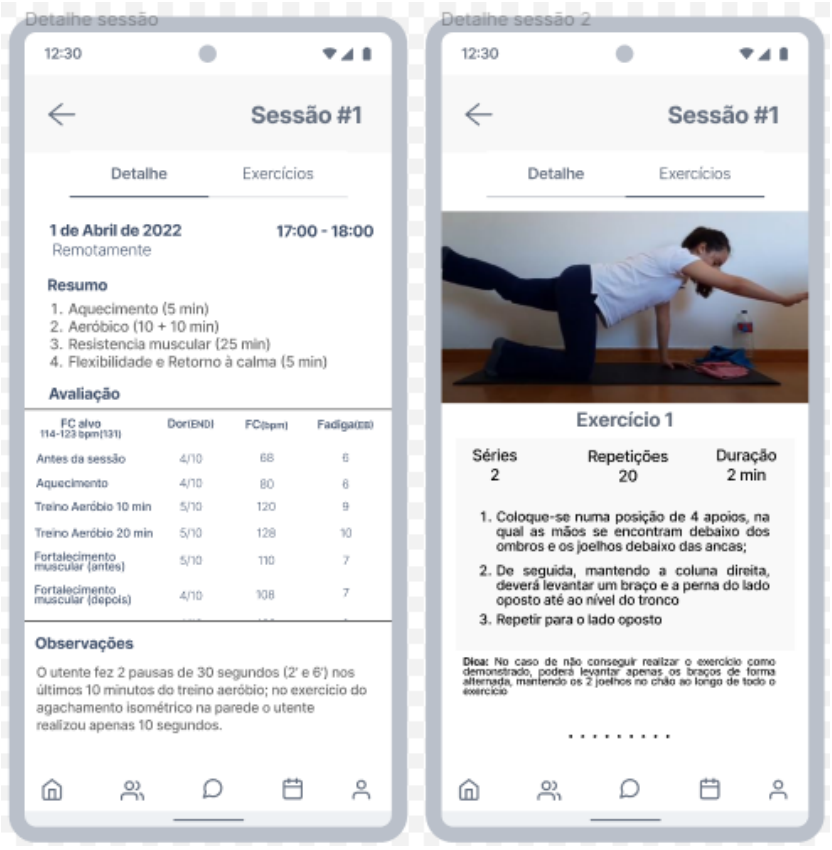

Figure 12 - Prototypes related to the session's component

Profile

One of the relevant topics in this solution is people's self-management of their condition. With this in mind, it was proposed to have a profile, which would work as a kind of diary, where people would record their level of pain and its location, sleep time, fatigue index, flares, which would allow for better monitoring by their physical therapist. However, there was some concern that too much focus on the negative aspects of the pathology could have a negative effect on people's daily lives and how they felt. Since the intervention plan of the physical therapists with their patients foresees the answering of a set of questionnaires, it was thought of using these answers to create indicators that can be visualized graphically, thus having information about the evolution of these indicators over time. In this case the question was raised if these questionnaires should be filled out by the patients whenever they wanted, or during sessions, with the physical therapist being responsible for asking the questions and inserting the answers into the system. In general, people indicated that it would be better for the physical therapist to be the one responsible in order to clarify any doubts that the patients may have, and to avoid overloading them with that extra work, which could also be demotivating. However, in a future iteration of the solution, patients could also be allowed to answer these questionnaires so that they would not be so dependent on the physical therapist,

i.e., they could use the application without the need of the therapist. In addition, it was also considered that the application could store any personal and medical information that is relevant for the continued treatment of their condition. The prototype of these profile area can be seen in Figure 13.

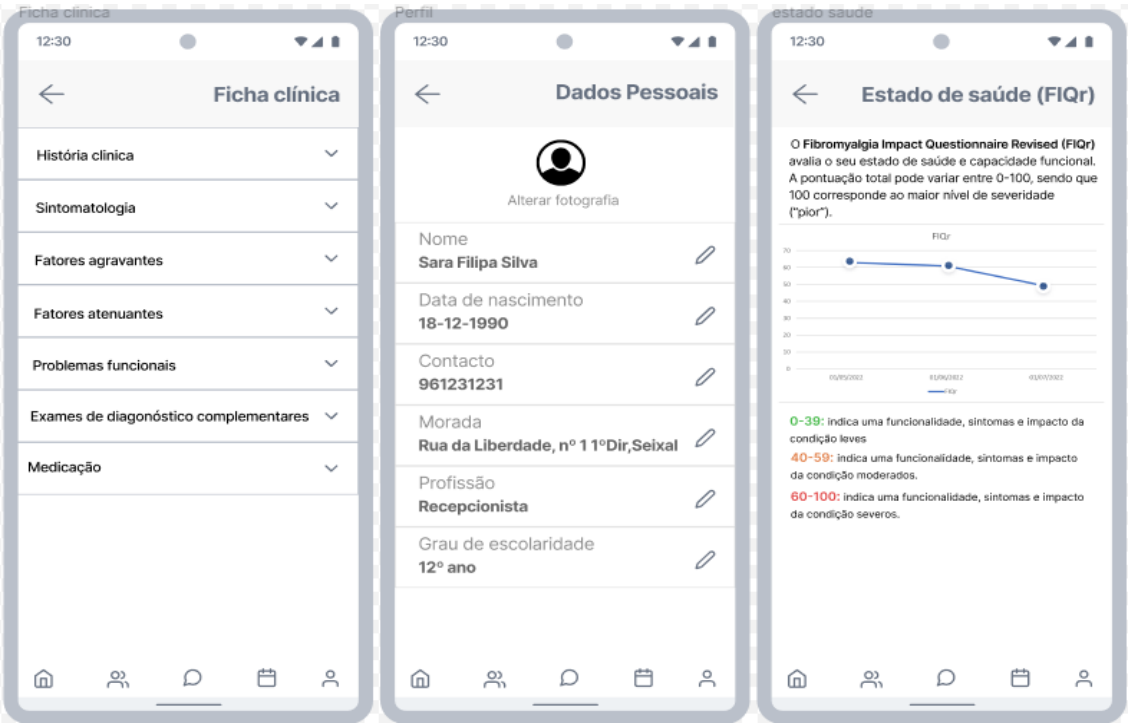

Figure 13 - Prototypes related to the profile component

Since there was no consensus about the type of device that the application should run on, it was decided that we would not be constrained to a single type of application, e.g., a desktop web application or a mobile application. However, since the focus is on the patients, and in general the proposed functionalities for this first phase of the project are well suited to be offered as part of a mobile application, the presented prototypes were created with mobile devices in mind. As presented in Figure 14, it was defined that the sessions and communication modules were the most important (priority 1), followed by user profile (priority 2). The motivation, the community part being left for future work (priorities 3 and 4).

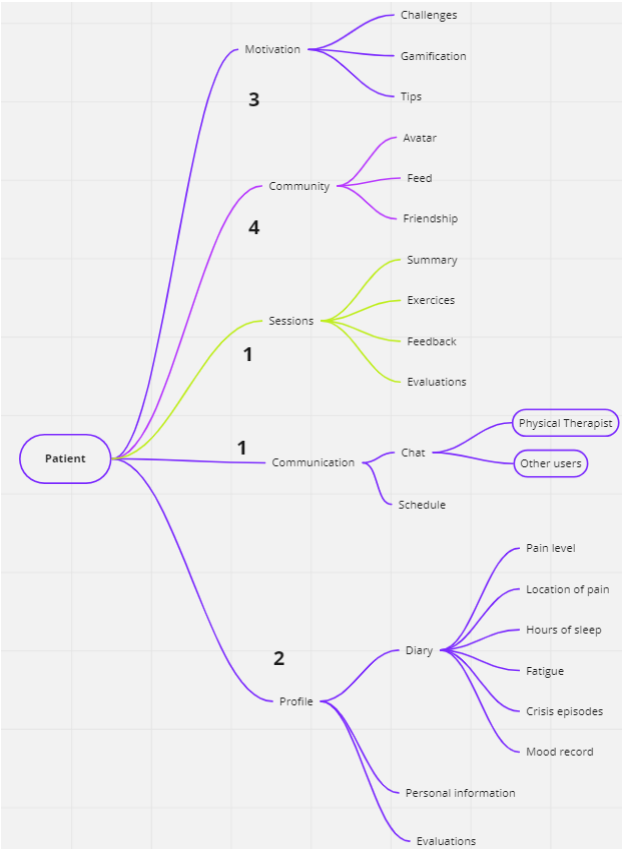

Figure 14 - Patient brainstorming

3.4. Last Workshops

The last three workshops were held at the end of May, with different people participating in each one. The first was held with people diagnosed with fibromyalgia, the second with physical therapists, and the last one with health researchers with approximately 10 people present. These people were already part of the team since they had participated in some of the previous sessions.

The purpose of these sessions was to validate the prototypes made, so that the whole team had an active role in the prototyping phase. Each person had to indicate any problems they could find, give their opinion about the functionality presented, and if they would change anything.

These workshops were structured in a similar way to the previous ones. Starting with an informal chat while waiting for everyone to enter the Zoom session, in order to break the ice. Then a brief introduction was made about the objective of the session, before presenting the prototypes that were created so far using *Figma* and asking questions about each of the presented functionalities. The focus was on clarifying some existing doubts, including as aspects such as the provided user experience, or the information that was presented on the prototype's screens.

In general, people liked the prototypes a lot, being quite happy about the look and functionalities presented, but there were some screens where possible improvements were pointed out that without these workshops would have gone unnoticed.

The session detail screen allows the patient to view some metadata regarding a certain session, such as date and time, summary, evaluation and observations made by the physical therapist (see Figure 15). The objective of this section was to show the evolution of various indicators (pain, heart rate, and fatigue) throughout the session (before the start, warm up, aerobic training, before and after muscle strengthening). First it was indicated that the monitoring of these indicators was excessive, as it could break the pace of the session too much with the physical therapist always asking questions to the patient during the session. In addition, there was a concern that the focus would be too much on the negative aspects such as pain and fatigue, and this information might not bring much benefit to the patient, or it might even be harmful at a psychological level. Finally, it was mentioned that the user experience might not be the best because it was not easy to analyze these results, because for people the numbers shown are meaningless. The suggestion to improve this section was to reduce the moments of evaluation of these indicators to beginning, middle and end, as well as to place these results in a more appealing way, e.g., three-line graphs, one for each indicator as seen in Figure 16.

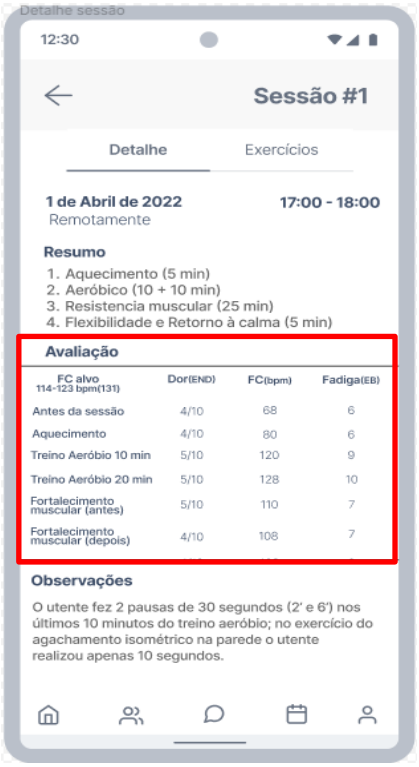

Figure 15 - Session Detail Prototype, focusing on evaluation section

Figure 16 - Session Detail Prototype, focused on changing the evaluation section

Also, regarding this screen, it was suggested to add information about the equipment needed to perform the exercises that compose the session (see Figure 17).

Figure 17 - Session Detail Prototype, equipment section

On the session screen, besides the detail, there is also the set of exercises that have been performed or, in the case of an autonomous session, the exercises to be performed. These exercises can be visualized through a horizontal scroll, that is, going from one exercise to another by swiping your finger to the right or to the left of the screen of the device. It was given the suggestion of adding a start, stop and finish button so that the autonomous sessions can be more dynamic. That way it would be possible to get some insights concerning the person's session, such as the duration of the session, the existence of any stop and the reason for it. Additionally, it was suggested to show an encouraging sentence when ending the session to motivate the users (see Figure 19).

Figure 18 - Session Exercises Prototype before changes

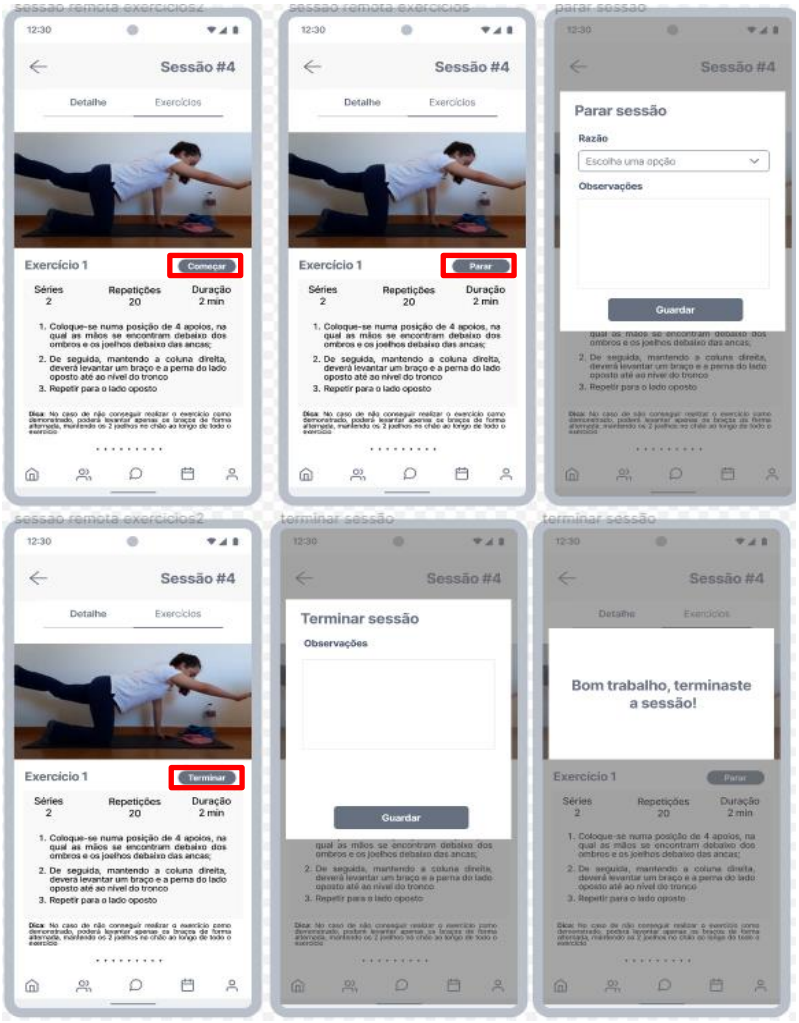

Figure 19 - Session Exercises Prototype after changes

A new screen was created that allows patients to see the list of exercises performed between every session. This had the same behavior as the exercises within the sessions screen explained above but contained more exercises because all the exercises from all the sessions were grouped together (see Figure 20). The feedback was that the way the exercises were presented was not quick and easy to search through. Therefore, it was suggested that this screen should instead list the exercises in a textual way, i.e., by showing only their names. In case more information was needed about them, it was only necessary to click on their name to open the detailed view. To make the search even easier, a filter by type of exercise was suggested (see Figure 21).

Figure 20 - Exercises Prototype Screen, before changes

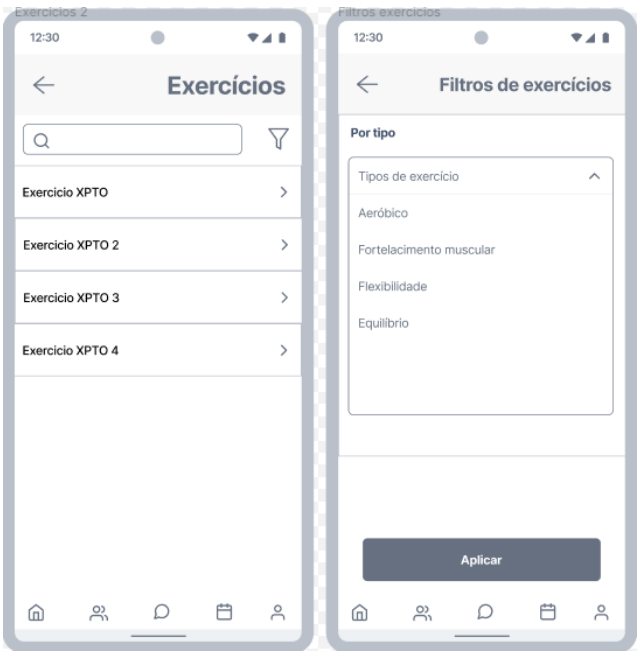

Figure 21 - Exercises Prototype Screen, after changes

The group challenge detail screen contains information about the number of meters the group has to reach together, as well as how many meters each person has contributed so far towards the goal. In this regard, some people indicated that it could be demotivating to see that their colleague has done more meters than they have (see Figure 22), thus contributing more to the final goal, but others could find this challenging and motivating. With this in mind, it was decided to have an option that allowed users to hide/show this information according to their preference, as seen in Figure 23.

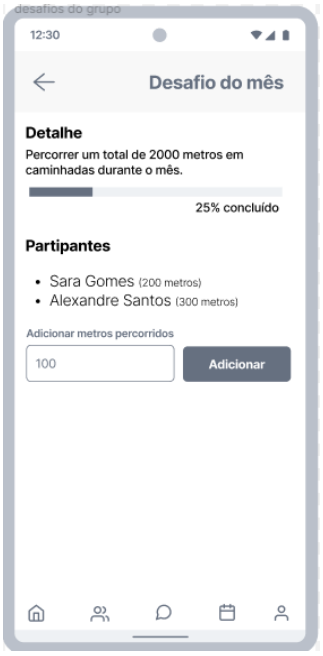

Figure 22 - Group Challenge Details Prototype

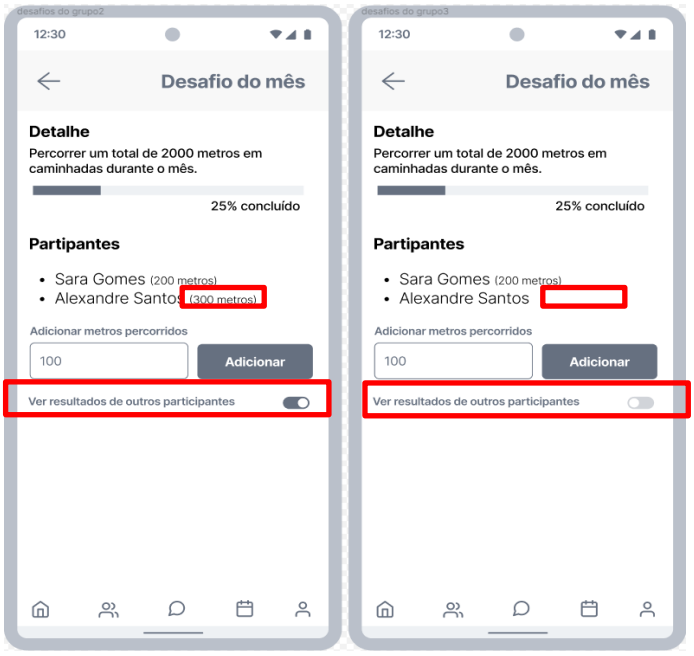

Figure 23 - Group Challenge Details Prototype changes

Regarding the patient's profile, there is a section where the indicators generated through the answers to the questionnaires throughout the physical therapist's intervention plan can be found. According to people, the chart of one of these indicators (Pain) was too complex, having too much information, which was not easily understood by them. The screen of this indicator allowed the visualization over time of the minimum, average and maximum degree of pain, which had too much focus on pain, which could lead people to becoming too concerned with this information and psychological affected (see Figure 25). To simplify this screen, it was proposed to present only the information of the average pain over time, as seen in Figure 24.

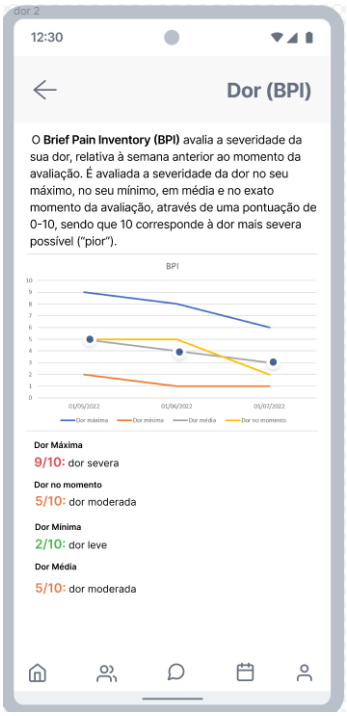

Figure 24 - Pain Indicator Prototype, before changes

Figure 25 - Pain Indicator Prototype, after changes

There was also a very interesting idea related to this indicator that should be considered for future versions of the application. The suggestion was that it should be possible for the user to specify where the pain was felt, e.g., on a body chart, in addition to the pain scale.

3.5. Summary

The contribution of the team during these workshops was very important to gain the necessary knowledge about the problems that a telerehabilitation-based solution might have. Without the help of everyone involved, the process of creating this solution would be much more difficult and much less credible, because we would be working just on some assumptions and the decisions would have to be taken without being sure that they would fit the needs of the

target audience.

In summary, some crucial points have been identified that one must take into consideration when creating technological solutions to improve the living conditions of people with the diagnosis of fibromyalgia.

Communication is a very important aspect, because it is through communication that it is possible to create a healthy relationship between patient and physical therapist, and in a telerehabilitation setting the proximity between both can be affected. So, mechanisms that promote a close relationship between both should be considered.

Additionally, methods that promote motivation for physical activity should be considered, because one of the symptoms that this pathology causes is extreme fatigue and sometimes life circumstances may also hinder the motivation needed to perform physical activity, thus failing to comply with the recommendations made by the physical therapist.

Another topic that can also be included in the motivational part is the sense of belonging. Often people with this pathology do not feel understood by their family, with symptoms being devalued or not given the importance they deserve. For this reason, community components must be taken into account so that people with this pathology can help and motivate each other.

One of the concerns that must be kept in mind is the safety while performing exercises in non-presential session contexts. Otherwise, it may cause a worsening of the symptoms of the pathology. Therefore, mechanisms that mitigate this lack of safety should be included so that it is not an obstacle to the adoption of solutions like this one.

Many patients cannot afford to have a physical therapist for an extended period, e.g., due to financial constraints, travelling or scheduling difficulties, or geographical location. Therefore, tools that enable them to manage their condition autonomously, as well as to perform physical exercise are very beneficial.

Chapter 4 will present the solution considering these crucial points as a follow up to all the work described in this chapter.

Chapter 4

Solution

This chapter describes the technological solution (SELFIE) developed from the information collected throughout the research process described in chapter 3. It will explain the decisions related to the architecture of the solution, as well as explain all the functionalities. The final solution of this research project needs to consider the needs of two main players, patients and physical therapists. However, in this dissertation the focus was on creating the application that will be used by patients.

4.1. Features

This section presents the list of features that the application provides considering all the work done in chapter 3, in order to synthesize and promote a better overall understanding of the solution before more detailed explanations are made in the following sections.

In Table 21 it can be seen these features divided by modules. The modules Gamification, Session, Communication, Notification and Health were all mentioned in the previous chapter, and most of their respective features met what was idealized. The Management module was thought to define the features that are common and essential to the operation of most applications, so their respective features were not idealized in workshops with the participants.

Modules	Features
Management	Create account/Activate account/Login
	Reset/Change password
	Change account information/Change profile picture
Gamification	View the progress of the current month's sessions
	Allows the patient to be integrated in group challenges related to walking, with the possibility of registering the number of meters walked. It also allows the visualization of how many challenges have been completed.
Session	List of sessions with the possibility of filtering them.
	List of the exercises performed in all the sessions with the possibility of filtering them
	View sessions in a calendar.
	View the detail/exercises of a particular session, with an accompanying illustrative video.
	Perform an autonomous session with start, stop, end options.
	Change the date of an autonomous session, as well as add comments to it.
	Conduct remote sessions through video call.
Communication	Communicate with the physical therapist, or in a group created by him/her, through a chat.
Notification	Receive notifications about the next session via email and push notification, with the possibility to enable/disable it
Health	Graphically visualize the evolution of four clinical indicators (quality of sleep, pain, fatigue, and state of health together with functional capacity) through questionnaires carried out by the physical therapist.
	List of relevant information about the disease.

Table 21 - SELFIE features

4.1.1. User interfaces

This section has the objective of presenting SELFIE application by showing its various screens, the previously listed features, and its navigation flow, in order to better understand the proposed solution.

Account setup

To enter the private area of the application, the patient must first register. This registration consists of filling in a form in three steps with different types of information being filled in each one of them. The first stage is related to application itself (email and password), while the second and third stages gather more personal information (see Figure 26).

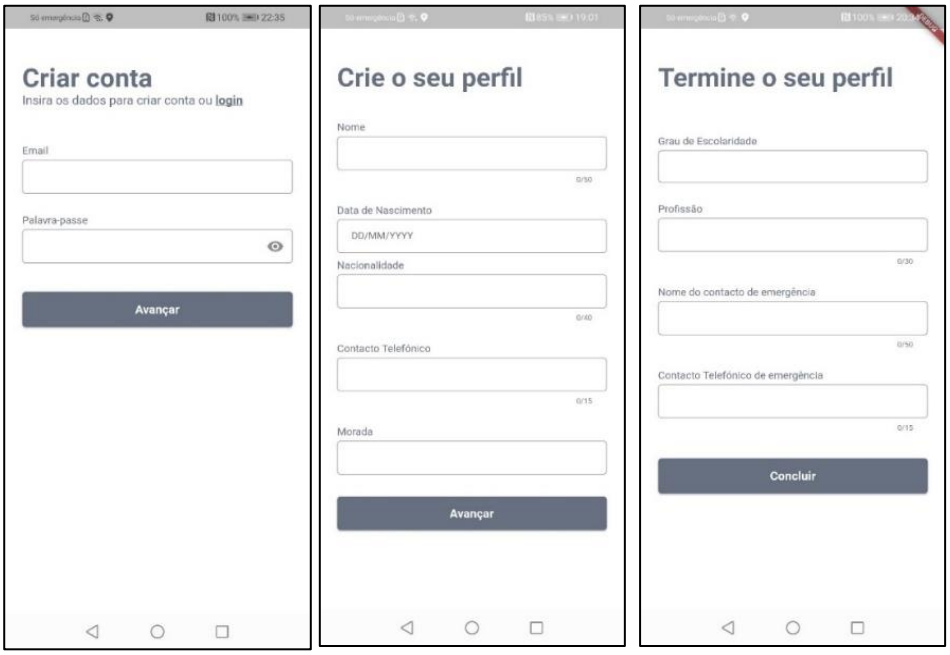

Figure 26 - Three Step signup flow screens

After finishing the registration, an e-mail is sent to the person in order to confirm that the e-mail used for the registration belongs to him/her. This e-mail contains a code that must be entered in the activation screen (see Figure 27), if this code is correct the account is activated and ready to be used to login.

Figure 27 - Activate account screen

If a user does not remember his/her password, it is also possible to reset it by entering the email address associated with an account. A code will be sent to this email, which can be entered in the change password screen, as well as the new password, as shown in Figure 28.

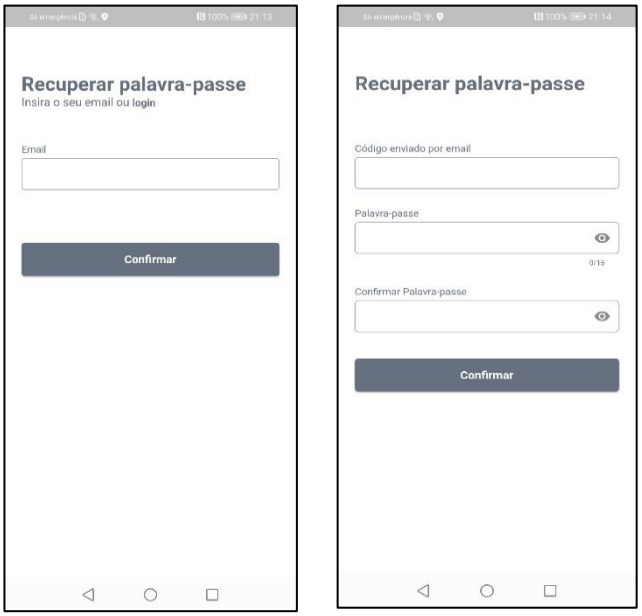

Figure 28 - Reset Password flow

Dashboard

When a login is successful, the user is redirected to a dashboard screen. This dashboard is composed of gamification component, i.e., a bar that increases as people perform their sessions of the current month (see Figure 29). The idea is that they feel motivated and can fill up the bar before the end of the month.

Figure 29 - Dashboard screen

Sessions

There are two ways to view the set of sessions that have been completed, or that are yet to be done. The first way is through the sessions screen. This screen lists sessions occurring in the next two weeks and highlights the next session. A finer search of the displayed sessions can be made through the textual search, i.e., by looking for the sessions that match the text inserted by the user, or by filtering by type of session (presential, remote or autonomous) and date range, i.e., sessions that occur between two dates (see Figure 30).

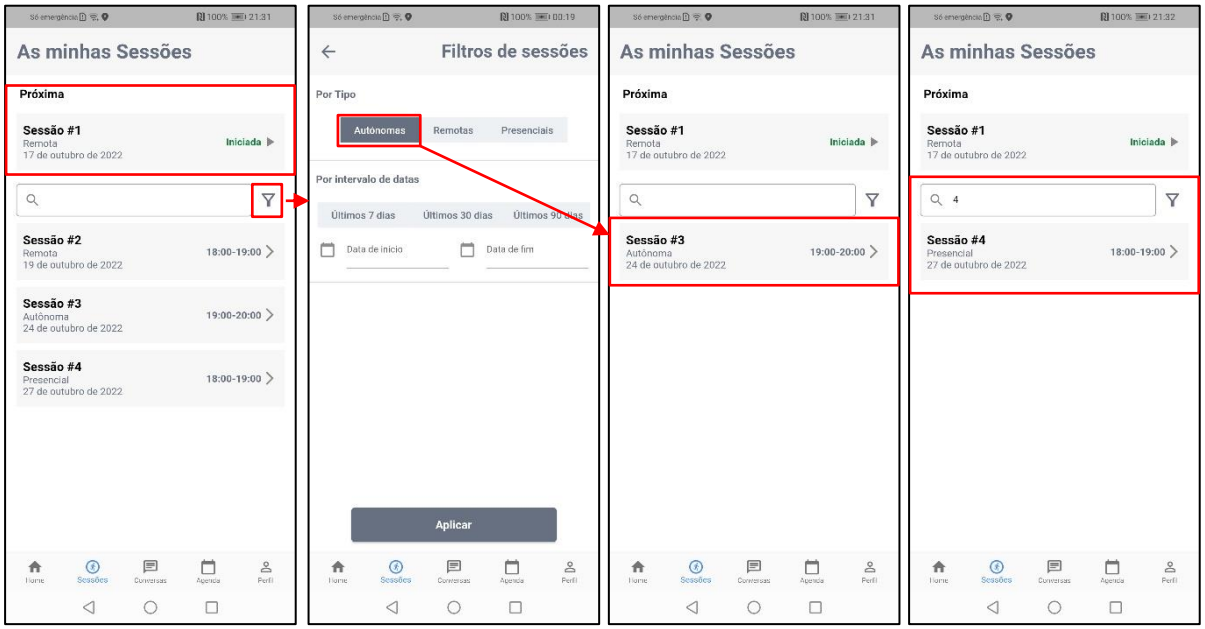

Figure 30 - Session list screen

The other way is through a calendar which allows the user to have an easy overview of the sessions in each month. By default, the initial month is the current one, but it is possible to navigate to select any other month. The various sessions that will be, or have been held, in a month are represented by a black ball in the respective day. By clicking on these days, a brief information about the session is presented below the calendar. If you click on days with no associated sessions, nothing is shown. In addition, the current day is highlighted to make it easier to identify it. This flow can be seen in Figure 31.

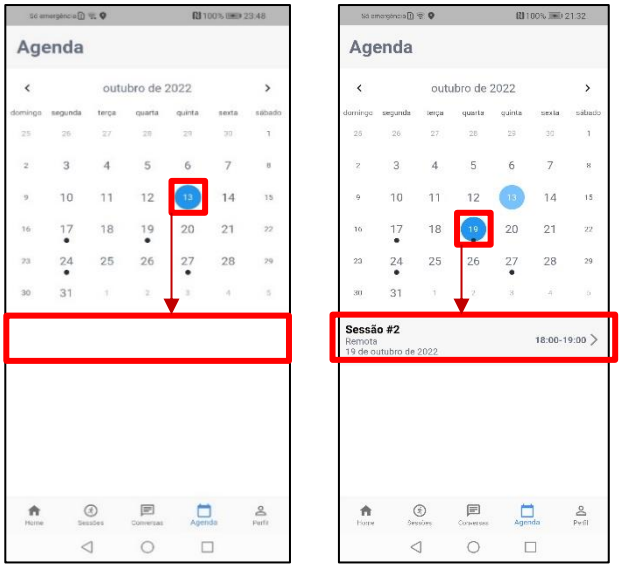

Figure 31 - Session Calendar Screen

The information related to the sessions is simplified on both screens, with only the essentials being presented, such as the name of the session, the type (Remote, Autonomous and Presential), and the date and time. Clicking on the session opens the detail screen that, in addition to this information, shows the equipment needed for the exercise, the session summary, its status (not done, in progress, stopped or completed), evaluations, observations and the exercises that are part of the session.

The evaluations of the sessions consist of the physical therapist recording pain, heart rate, and fatigue in three phases of the session (beginning, middle, and end) during the session, allowing the evolution of these indicators to be shown later using line charts (see Figure 32). Therefore, this information is only presented in remote and in presential sessions.

Figure 32 - Session evaluation

The physical therapist can also write down notes that he/she thinks are relevant to the session, in the case of remote and presential sessions, so that the patient can view them later. If the session is autonomous, the patient is the one that writes observations for the physical therapist to view later in the details page (see Figure 33).

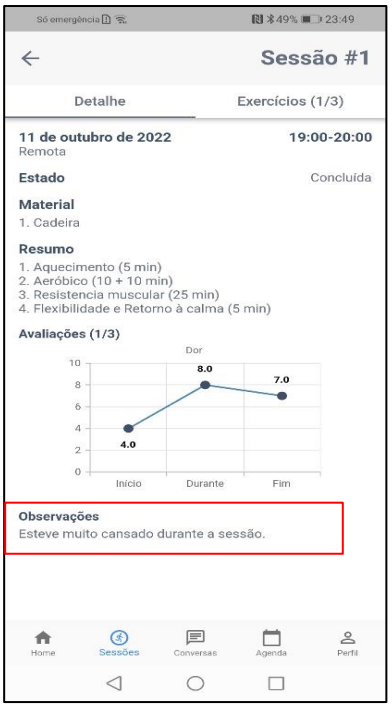

Figure 33 - Session observation

Regarding the exercise section, the intention is to list all the exercises that have been done (in the case of a remote or presential session) or that will be done autonomously (in the case of an autonomous session). The information for each exercise consists of a textual and visual explanation through a video, the number of sets, repetitions, rest time and eventual notes, for example easier/harder variations of the exercise. The exercises are visualized one by one and through a horizontal scroll it is possible to change the exercise you are viewing.

In order to make the autonomous sessions more dynamic, it is possible to start, stop, restart and end the session. When the session is started, its status changes to "In progress", during the session it is possible to stop it by giving a reason and observation (see Figure 34) and restart it later. Finally, after the exercises have been performed, you can end the session, leaving it with a completed status, as seen Figure 35. This flow is presented in Figure 36 by means of a state diagram.

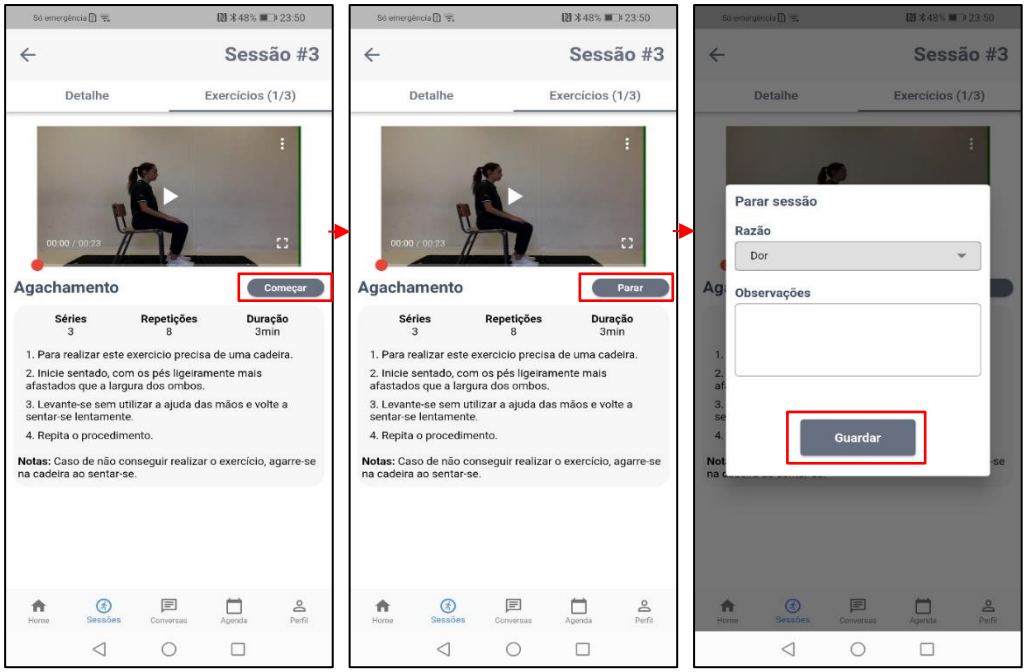

Figure 34 - Start, stop session process

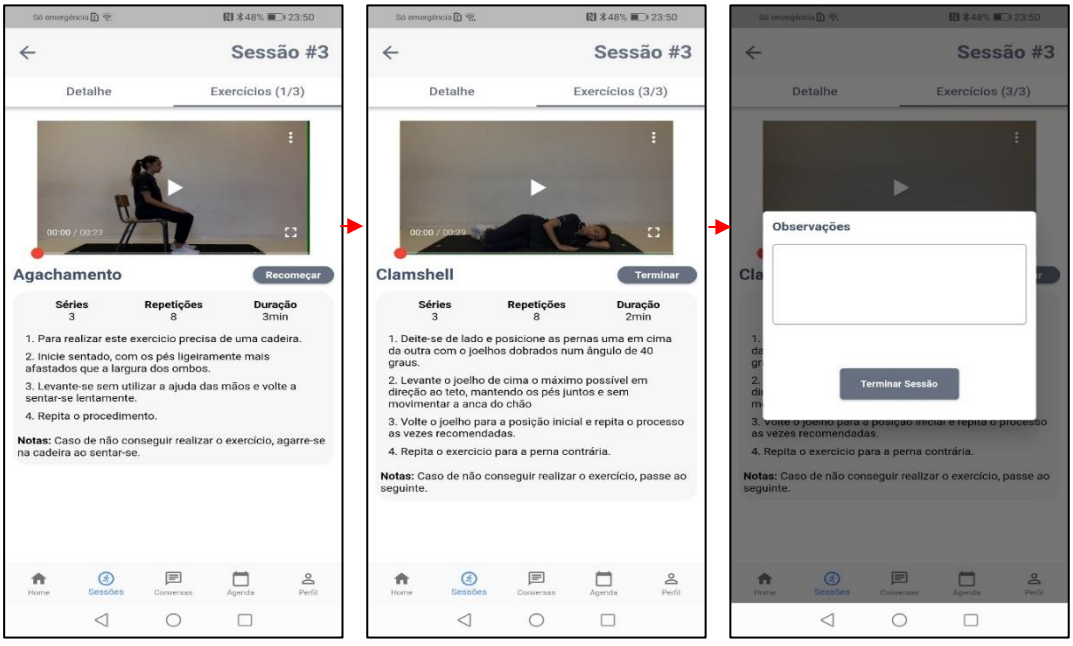

Figure 35 - Restart, finish session process

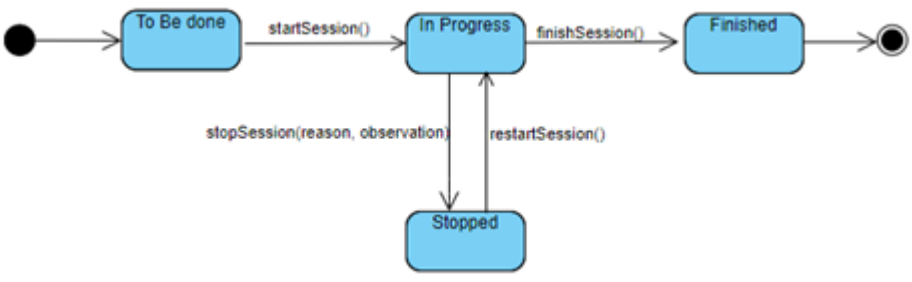

Figure 36 - Autonomous sessions state diagram

When the sessions are remote, the physical therapist will be responsible for starting the session, changing the session status to “In Progress” as indicated in the application. From that moment, if the session is clicked on, a video call is launched within the application so that the session can be held (see Figure 37). Once the session is over, the physical therapist will finish the session, updating its status to "Finished". Figure 38 shows the logic flow of a remote session.

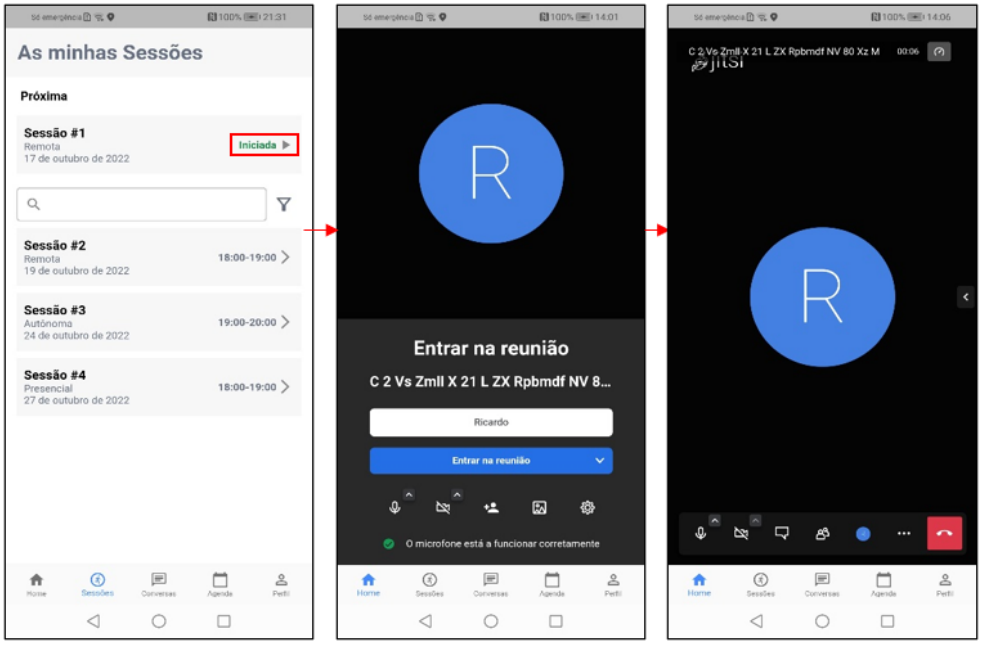

Figure 37 - Video conference screens

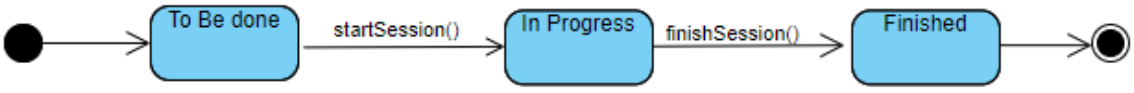

Figure 38 - Remote sessions state diagram

For the presential sessions, the application will only register the session information and will not play an active role in the session. Thus, it only has the status “To be done” and “Finished”, as can be seen in Figure 39.

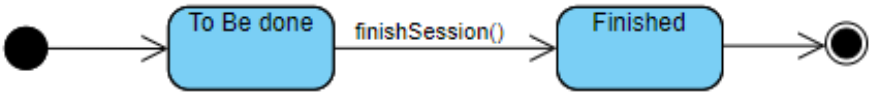

Figure 39 - Presential sessions state diagram

Exercises

In addition to the session screen that shows the exercises that are part of a session, another screen was created in order to group all the exercises performed throughout all the sessions. This screen presents a list of these exercises, allowing you to search them by text and filter them by type of exercise, as can be seen in Figure 40. Its purpose is to provide the user with a faster and easier way to find an exercise, instead of having to go to each session looking for it.

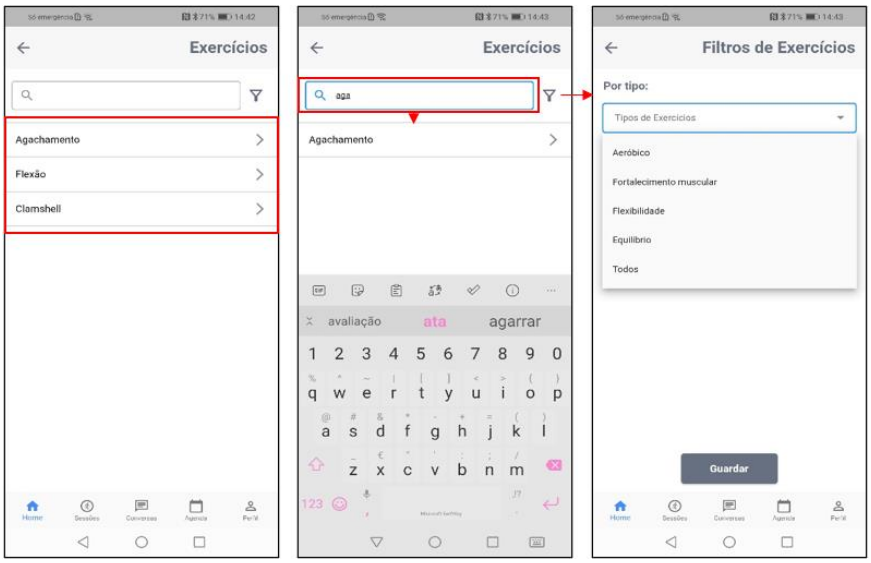

Figure 40 - Exercise's screen

Group Challenges

The physical therapist can create groups that should complete certain challenges. Currently, these challenges consist of the group members walking a certain number of meters which are added up to complete the objective. Initially, the patient will be able to see the number of challenges that have been completed by the groups to which he/she belongs, as well as the list of ongoing challenges with the information of the total meters to cover, a bar to check the overall progress, and the number of participants. Clicking on the challenge opens the detail screen, which in addition to the previously mentioned information, shows a description of what the challenge consists of, the percentage of completeness, and the list of participants and the number of meters that they contributed towards the challenge. The latter can be hidden through a toggle, i.e., if it is active, it shows the distance walked by all the participants, otherwise it only shows the distance walked by the current user. To register the distance covered during a walk, the user should introduce the number of meters in a text field and click add. The information on the screen will be automatically updated to reflect the value introduced by the user. This flow is shown in Figure 41.

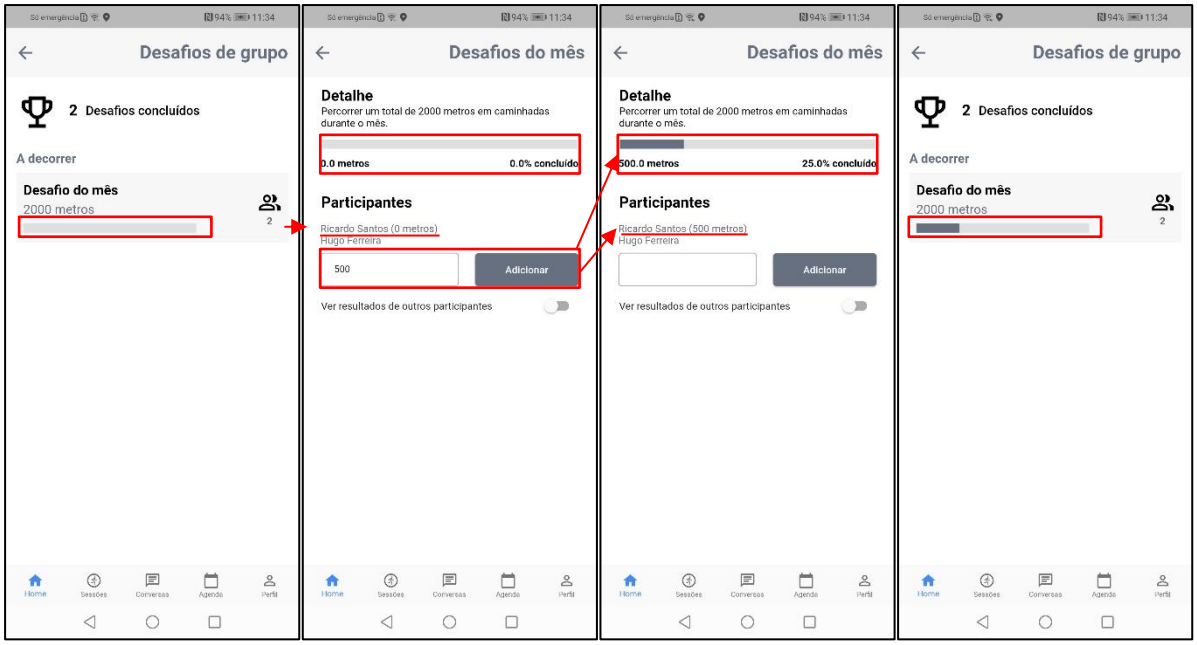

Figure 41 - Group challenges screens

Communication

The conversations screen is intended to list all the chats in which the patient is involved. Chats can be private between the user and the physical therapist, or they can be associated to the group challenges created by the physical therapist. Clicking in a conversation in this list will open it, and messages can be sent by using the text at the bottom (currently only text messages are available). The chat is in in real time so, as the messages are sent, the conversation is automatically updated on all devices that have the chat open (see Figure 42).

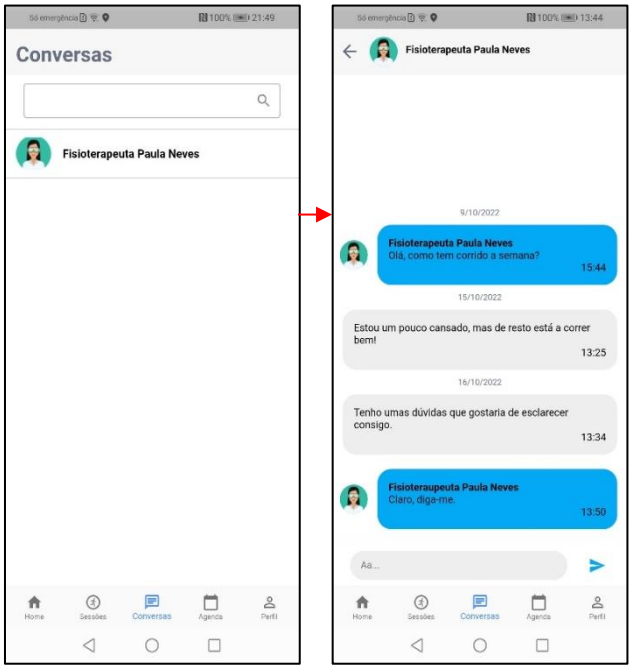

Figure 42 - Chat screens

Profile

This screen allows users to update their personal information and update their profile photo which will serve as their avatar in chats, as can be seen in Figure 43.

Figure 43 - Profile screen

Clinical data

During several phases of the physical therapist's follow-up with the patients, a series of questionnaires will be carried out to obtain results about some important indicators. This is needed to allow physical therapists and patients to understand the evolution of the disease over time. These questionnaires will be filled in by the physical therapist, so as not to overwhelm the patients with questions. The indicators are quality of sleep, pain, fatigue and health status, together with functional capacity, and are listed on the health data screen within the profile.

Clicking on each indicator will open its respective screen. This screen contains a brief explanation of what the indicator is and the values of the indicator on the dates when the questionnaires were carried out on a line chart. Below this graph, a legend is displayed explaining what a certain value in that indicator represents. For example, in the pain indicator, a value of 1-4 represents mild pain. In order to improve the understanding of the value on the graph, the value is color matched to the legend, with green being a positive result, yellow an average result, and red a bad result (see Figure 44).

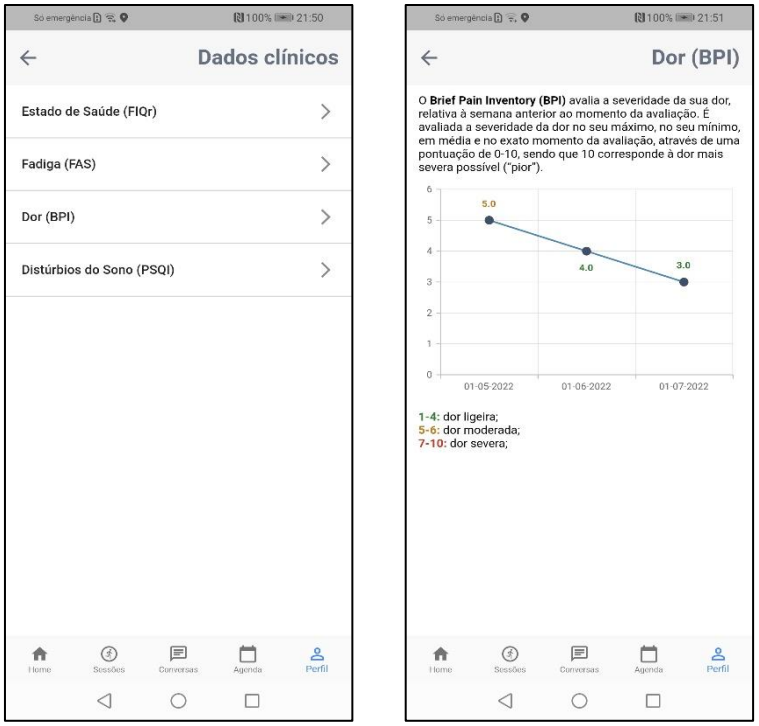

Figure 44 - Clinical data screens

Alerts

The day before each session a notification is sent to patients. This notification can be done in two ways: via email our through push notifications. Users can activate/deactivate each of these options through the toggles on the alerts screen, as shown in Figure 45. The purpose of these notifications is to serve as a reminder, so that people don't forget about the sessions.

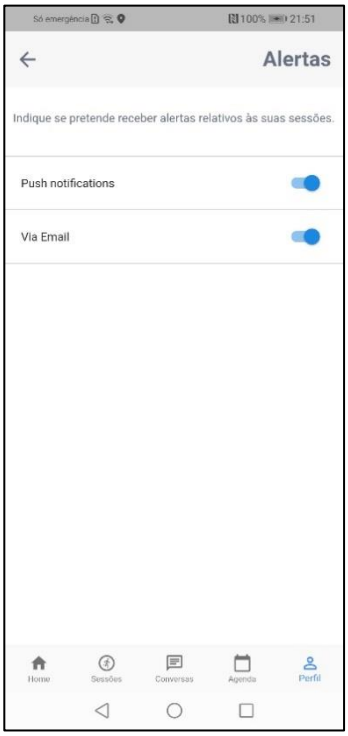

Figure 45 - Alerts screen

Tips

In order to promote the learning and understanding of the issues related to this pathology, a screen was created that provides relevant information about it, as well as frequently asked questions that can help to clarify some doubts in a more accessible way (see Figure 46).

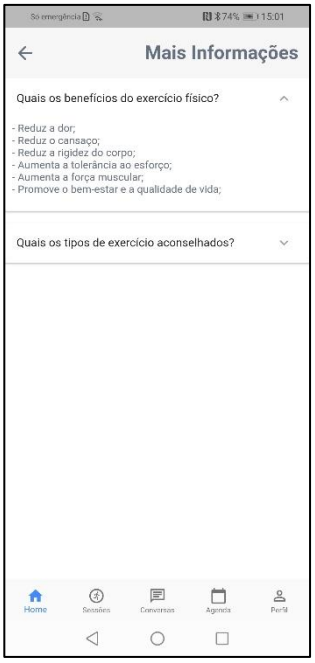

Figure 46 - Tips screen

4.2. Design Decisions

The way patients would use the solution was not unanimous among all team members, so it was decided that for the first phase of the project a mobile application would be developed but knowing that in the future it would be also necessary to provide a web-based version. With this in mind, the technology used should be versatile to the point of working both in mobile applications and web applications, so code can be reused thus taking much less time developing a web version.

First, it was thought to use a progressive web application because this type of application allows you to access it through the browser, as well as install it as an application on different devices (for example, smartphone, laptop, or tablet), all through the same code base. These kinds of applications are based on web technologies. Therefore, even though they can be installed to work on various devices, behind the scenes it is developed as it was a web application. Therefore, it is not possible to directly access some information about the underlying device (e.g., sensors, and lower-level software and hardware capabilities) which may limit the future development of new features.

The option chosen was the Flutter framework because it allows the development of the

application for different platforms using the same code base. The main difference is that it generates different applications for each platform, i.e., the mobile device will have a version of the application to run on the device (thus having access to all native sensors) and a version of the application to run in the browser, with the possibility of also having a desktop version.

Regarding the server side, these applications communicate with the server through an application programming interface (API), which performs operations on a relational database. In addition, all exercise videos and user photos are stored on the server which then exposes them through a content delivery network (CDN). This CDN is accessed by the application to make the content available to the users, meanwhile insertion operations, such as adding a profile picture, are performed by the API.

Some external services were used to develop some functionalities of the solution. An email service, which allows to send emails and to track their status (e.g., sent, unsent, or on the way,). A notifications service, to send push notifications to the patients' mobile phones. A video call service, so that remote sessions can be held. Finally, a real-time database for the creation of the solution's conversation system, so that whenever a new message is sent, the conversation is automatically updated.

Finally, in order to help manage the whole solution a Backoffice was created for the system administrators.

The overview of the key components of the solution explained above can be seen in Figure 47.

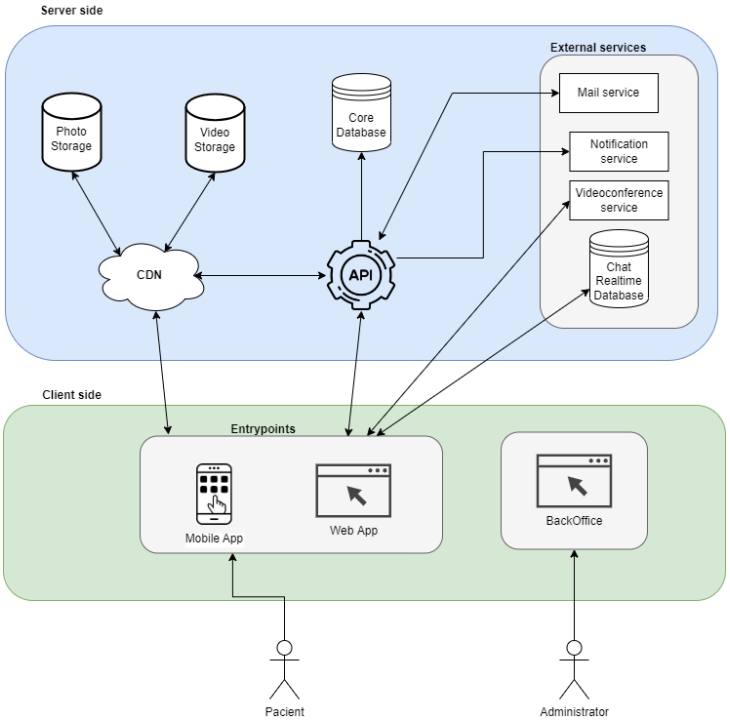

Figure 47 - Solution Architecture

4.2.1. External Services

This section describes the external services that were used to develop some of the functionalities of the solution. It should be noted that all the services used are free or have a free version.

Mailjet [2] was used as the email service. It was chosen because it offered useful features for the application. For instance, it allows the tracking of sent emails, i.e., to check whether an email was opened, or if an e-mail was sent and, in case it was not, the reason behind it. Additionally, it allows the creation of email templates graphically with the ability to change them at any time without the need to modify application code.

In order to send push notifications to the users' mobile devices, the Firebase Cloud Messaging [3] service was used. This service was chosen because it is cross-platform, i.e., it can be used by several computing platforms, thus having the possibility to extend this functionality to the future web version and other types of applications. Furthermore, this tool is very scalable allowing 1.500.000 messages/minute per project and up to 1.000 messages/minute per device. Depending on the device this value can change, e.g., for Android devices the limit is 240 messages/minute which is not a limitation for this specific project.

Since the chat should work in real time, i.e., every time someone sends a message the conversation gets updated on all the devices of the users that have that chat open, it was considered to create this system from scratch using network sockets, but the development process would be time consuming, it would not be extensible to all platforms, and there are already some solutions that can be reused to implement such behavior. Therefore, the Firebase Realtime Database [4] was used. This is a NoSQL database (a non-relational database) that allows whenever data is inserted, modified or deleted, it updates all connected clients. In this case, it updates the mobile application that is connected to it with the information of the currently open chat. Moreover, this service is also cross-platform.

A video call system is needed for the remote sessions, and since the focus of this dissertation is not to create such a system from scratch, the use of a service or tool was considered from the beginning. A few options were considered, but in the end, it was decided that Jitsi [5] would be used. This is an open-source tool that can be self-hosted, meaning it can be hosted on a private server managed by the team. This tool also provides a public server,

[2] https://www.mailjet.com/
[3] https://firebase.google.com/docs/cloud-messaging
[4] https://firebase.google.com/docs/database
[5] https://jitsi.github.io/handbook/docs/intro

where video conferences can be held without having to install anything. Basically, this allows the generation of a link which can be used to start a video call to hold remote sessions. At this point, and in order to carry out the tests that will be described in the next chapter, the public server was used. This version does not have any limitations that may hinder user experience in the current phase of the project, since it allows HD video, support up to 100 participants, remote control options and multiple people can share the screen.

4.2.2. Model

The class diagram in Figure 48 describes how functionalities were mapped to the developed system, thus giving a better understanding about them and about how the system was built.

First, two types of users were identified, the physical therapist and the patient. As previously mentioned, the application focuses on the patient, but it has some functionalities where the physical therapist has an indirect role.

Users can be present in multiple chats which are either associated to patient groups, or in a private chat directly with their physical therapist.

The group challenges are created by the physical therapists, who group a set of patients to complete a challenge. Moreover, patients can be part of various groups over time.

There are three types of sessions, in person, autonomous and remote, which are created by the physical therapists for one or more patients. Each session has a set of associated exercises, each exercise has several steps and the necessary equipment to carry them out.

Regarding the questionnaires, there will be a set of pre-made questionnaires. Over time each patient will answer to questionnaires in order to obtain the information needed for the indicators that are shown in the application.

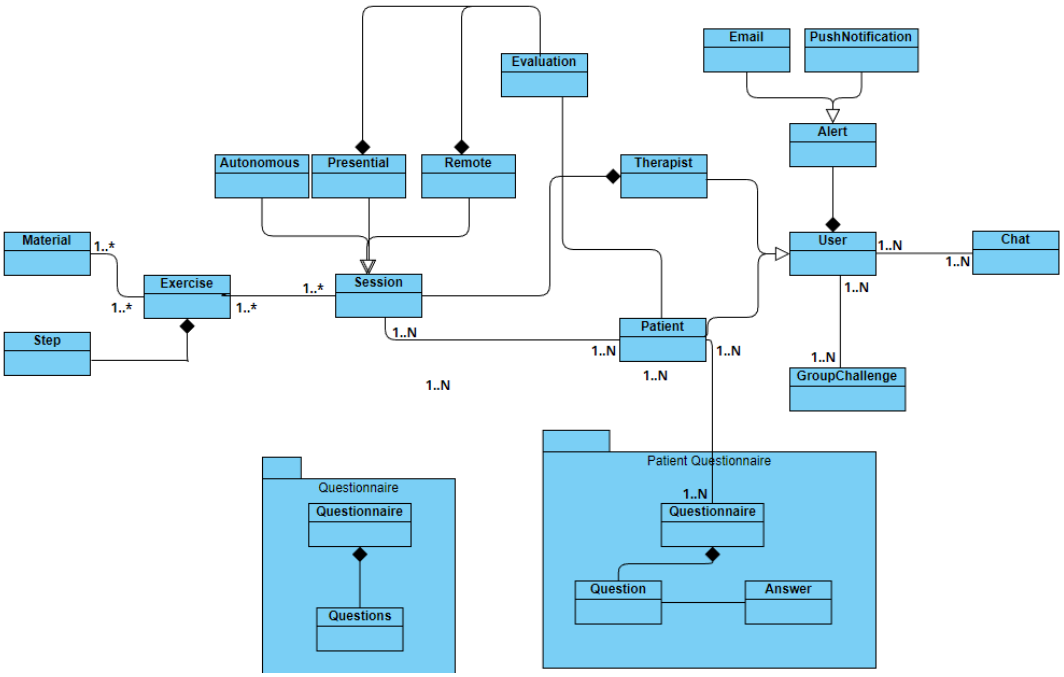

Figure 48 - Class diagram

Chapter 5

Evaluation and Results

This chapter presents the usability tests that were performed using the application introduced in the previous chapters. Afterwards, the results are analyzed and discussed. These tests occurred at the end of the development of the application, and after a series of internal tests carried out by the team to find possible bugs in order to have a version that is as stable as possible to present to potential users.

5.1. Usability tests

One of the main concerns of this application is its usability and user experience. It should be simple to use and intuitive to better help people with the diagnosis of fibromyalgia and to foster its adoption. It must be considered that this disease causes a lot of musculoskeletal pain and extreme fatigue. If the application is not easy to use it can cause frustration, and instead of having a positive effect on people it will have a negative effect which may lead them to stop using it. Therefore, we performed usability tests in order to evaluate the quality of the application based on people's understanding of the functionalities when performing a set of tasks within the application. By performing these tests, it is possible to analyze the application user experience in order to find points that can be improved to make it both easier and more pleasant to use. These improvements can be suggested by the person performing the test, or they can be proposed by the team conducting the tests in order to get feedback from the participants.

5.1.1. Participants and Evaluation Method

The usability tests had a total of 7 participants. All of them were women diagnosed with fibromyalgia in the last 2 to 17 years (μ= 5.86, σ= 4.76, median=5). These women were between 43 and 63 years old with an average of 51.29 years old and a standard deviation of 6.65 (median=52). Most of them were already familiar with using a smartphone and had little difficulty in starting to explore the mobile application. There were a few that were not so comfortable, but all participants owned a smartphone. It is also important to mention that all these people were not part of the previous phases of the project, so it was the first time they had contact with the application and its respective features.

The evaluation of the application was conducted by going through five scenarios with the participants. These scenarios consisted of the assumption that something occurred and, as a result, a goal would have to be accomplished by performing tasks in the application that were related to one or more of its functionalities.

The first scenario was related to the group challenges. It consisted of recording in the application a hypothetical number of walked meters, knowing that the physical therapist had previously introduced the person in a group that had the goal of walking a total of 2000 meters during the month.

The second scenario was to imagine that the person had doubts about an exercise and needed to contact the physical therapist by sending a message directly through the application.

The third and fourth scenarios were related to the sessions. One of them was related to remote sessions, in which the objective was for the person to join a remote session scheduled for the day of the test, in which the physiotherapist had already started it in order to simulate the realization of the intervention through video call. The other was related to autonomous sessions, in which, imagining that the physical therapist had proposed an autonomous session, the person went to the application and simulated it, using the buttons on the screen and the visualization of the exercises.

The last scenario was to imagine that the person had already had several sessions and throughout these sessions they had already answered some questionnaires. Therefore, they could use the application to analyze the results of the indicators that are based on these questionnaires, while trying to understand if the results are positive or negative.

After completing the scenarios, the user answered a questionnaire. This questionnaire assesses the user's sense of clarity, ease of use and understanding of the various functionalities of the application. The questionnaire is organized into seven sections. The first section merely

serves to identify the participant (see Appendix A.1). The second section relates to the participant's personal information for characterization purposes (see Appendix A.2). The third section has questions related to the diagnosis and treatment of fibromyalgia (see Appendix A.3). Section four is related to the experience with information technology (see Appendix A.4). Section five has questions about the scenarios to identify the relevance of the functionalities related to them in order to understand if they make sense and if they can help these people (see Appendix A.5). Section six is composed of questions adapted from the System Usability Scale (SUS) questionnaire (Brooke, 1996), translated into European Portuguese(Martins et al., 2015), in which a seven-point Likert scale was used instead of the usual five-point Likert scale, since it is more likely to reflect a respondent's true subjective evaluation of a usability questionnaire item than a five-point item scale (Finstad, 2010). This format asks how much the user agrees or disagrees with a statement and was also used in the previous section. Section six question can be seen in Appendix A.6. Finally, the last section serves to provide additional feedback on the application (see Appendix A.7).

The total duration of a user test, including the completion of the questionnaire, was about one hour and was carried out individually with the support of team members from both the technology and physical therapy areas.

5.2. Results

This section presents the results of the questionnaires that were answered by the participants in the user studies. The main focus are the questions related to the scenarios and the corresponding main functionalities of the application, as well as general usability questions, as can be seen in the appendix B.

5.2.1. Scenarios

The scenarios performed by people were important for them to understand the application as a whole and to assess if its functionalities were easy to use. In addition, it served as a validation of the entire process that was carried out before the development of the solution, as it allowed us to understand if the functionalities provided by the application were indeed relevant, important, and appropriate to solve the problems for which they were designed.

In general, all participants were able to perform the scenarios quite easily and quickly. It was interesting to note that even before the end of the scenario explanation many people were already performing the scenario, thus demonstrating that the application was very intuitive to the point that they could replicate what was asked of them without needing all the information.

As mentioned earlier, there was section in the questionnaire dedicated to the scenarios with a set of statements that had to be rated using a Likert-type scale, ranging from a value of '1' ("strongly disagree") to a value of '7' ("strongly agree"). In this case the statements were structured in a positive way, so a score of 7 was always the best score. These results were very positive. All questions scored a minimum of '6', being very close to the best value of '7'. The standard deviation is below the value '1' indicating that there was low variability in the question scores, as shown in Figure 49.

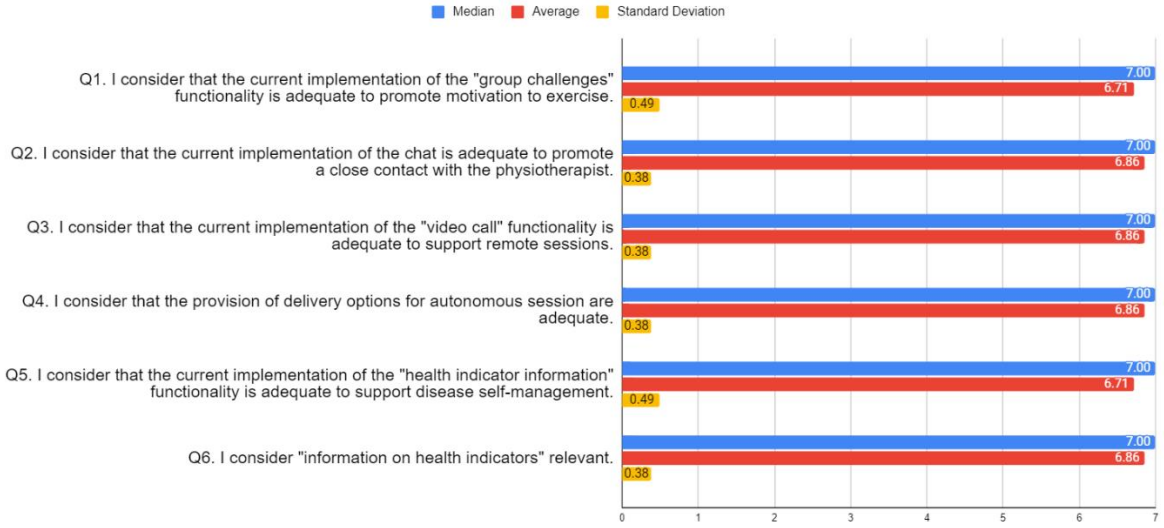

Figure 49 - Results of scenarios functionalities questions

Although the participants were able to complete the scenarios and some the questionnaire has great results, some functionalities were detected that were more difficult to understand at first glance through observation, i.e., participants did not state it directly, but the team noticed some difficulties. Regarding the group challenges, some people couldn't understand right away that they had to put the value of the meters traveled into the field and then click add. Some people would first click on the button and wait for some dialog to appear to insert the value. To improve this aspect, it was thought to add an explanatory text above the input field and the add button, indicating that a numeric value should be inserted before clicking on the button. About the conversation scenario with the physical therapist, some people did not realize that to send a message they had to first open the conversation, so instead they used the search field to try to that. Finally, in the scenario of the autonomous sessions, the way to pass from one exercise to the other was not very perceptible that is should be done through a swipe, so it took a while for the participants to figure out how to perform this operation. In order to mitigate this difficulty, it was idealized to add two arrows, one pointing to the left and the other to the right in order to suggest the swipe movement.

5.2.2. Usability

Like the previous section, the usability section of the questionnaire also uses a Likert-scale ranging from a value of “1” ("strongly disagree") to a value of “7” ("strongly agree"). However, in this case some questions the value “7” did not correspond to the best result, that is, evaluating with the value “1” is better than “7”, such as the question "I found the Selfie application more complex than necessary". This is due to the fact that the structure of the question is done in the opposite direction. Of the 10 questions asked the ones that the best score would be “1” are the second, fourth, sixth, eighth and tenth.

The participants' overall outcomes were very positive. As can be seen in Figure 50, all questions where a higher value indicates a better outcome had an average above the value of "6" and all questions where a lower value indicates a better result had an average below the value of "2".

The score result for the application was 97.22 on the SUS Scale, and this means that the results can be interpreted being in the 96th to 100th percentile range (Lewis & Sauro, 2018). This score is within the range of a *Best Imaginable* usability rating and an A grade (Bangor et al., 2009).Even if we consider the lower bound of the Student’s t distribution 95% confidence interval of [93,75,100], this rating will still hold.

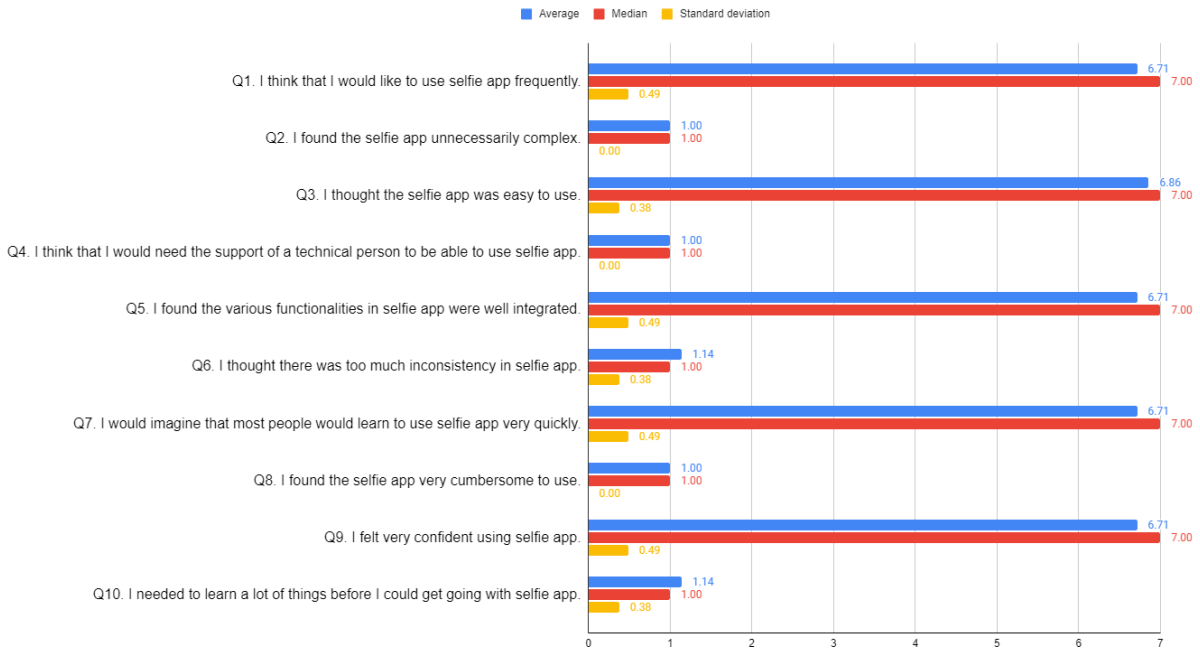

Figure 50 - Results of usability questions

All questions had a standard deviation of less than 1 and very close to zero, meaning that there was no great discrepancy between the participants' opinions.

Although these results are good, it is important to mention that it would be important to have a larger group of people with fibromyalgia to perform these tests. Initially 12 tests were planned to be carried out, but only 7 were showed up for the tests, this is due to the fact that this disease is unpredictable, people do not know how their symptoms will be on the day of the test, and often these symptoms are so severe that they cannot get out of bed and have a "normal" day. Therefore, with a larger number of participants these results could tend to have slightly worse results, but it would be expected that they would remain quite positive since the current variability is low.

In addition, observation measurement metrics could be carried out in order to have a wider and more diverse set of data for evaluation, such as measuring the execution time of a task, counting the number of help requests requested and the number of errors made.

Furthermore, all these tests were carried out in a controlled environment and in a short period of time, so the margin for error or difficulty was not very high. Therefore, in the future, it would be important to carry out more “in the wild" tests with more time of use, where people could install the application and use it for, at least, a week so that at the end they could fill out a new questionnaire and the results could be compared with the initial ones. In this way it will be possible to identify new problems and ensure with greater confidence the usability of the application and the relevance of its functionalities.

CHAPTER 6

Conclusions and future work

This chapter presents the conclusions to the research work developed during this dissertation, as well as the future work that can be done to expand and improve it.

6.1. Conclusions

This dissertation had as main purpose of studying, designing and implementing a technological solution whose purpose is to help people diagnosed with fibromyalgia in the daily self-management of the symptoms caused by the pathology, as well as to promote tele-rehabilitation with their physical therapists.

By adopting a Co-Design methodology, Design Thinking, the design of this solution was divided into five phases: empathize, define, ideate, prototype and test, that lead to the conduction of 7 workshops. Each of these phases was carried out by a team, consisting of a group of researchers, students, physical therapists, patients diagnosed with fibromyalgia and representatives of organizations associated with this condition.

The goal of the first and second workshops was to establish a relationship with all the team members, allowing them to more easily identify the needs that the solution would have to address. Later, in the third and fourth workshops, some functionalities that could be part of the solution were idealized. Before the last workshops, several brainstorming sessions were held in order to define what would be the priority for an initial version of the solution, as well as to build the first non-functional prototypes. In the last three workshops, these prototypes were presented in order to validate and modify them based on some of the suggestions that

emerged.

Thanks to these workshops, it was possible to identify some key points that need to be considered when developing an application for self-management and remote treatment for people suffering from fibromyalgia. Communication, motivation, and sense of belonging (in the community) were the most talked about aspects that were considered to be important for this type of solution. Another important aspect was the creation of tools to help patients by promoting the practice of physical exercises in a correct and regular way, either autonomously or though remote interventions with their physical therapist.

Therefore, SELFIE was developed using the Flutter framework, in order to create a mobile application in a first phase, but later it may also be made available as a web application. The main features of this application are the group challenges, where each person can be inserted in a group created by the physical therapist, whose challenge consists in walking a certain number of meters during a month. In addition, sessions are available remotely, in person, and autonomously, with all of them containing detailed information about the exercises performed, which can be consulted in video and text format. An integrated chat was also developed, in order to foster communication between the physical therapist and the patient, but also with other people in your group challenge. In order to better self-manage their condition, it is possible for patients to analyze the evolution/regression of the state of their pathology through charts resulting from the completion of questionnaires throughout the sessions that are filled with the assistance of the physical therapist. These charts are divided into some main indicators, such as: pain, health status, sleep quality and fatigue.

Concluding the development of SELFIE, a set of tests were performed with people with the pathology, but who did not belong to the solution design team. The feedback was very positive, in which all people indicated that the functionalities were adequate and relevant, as well as the application was intuitive and easy to use, obtaining a SUS score of 97.22. These results allow us to demonstrate the importance of using co-creation methodologies for this type of research, in which the target demographic was involved, in this case people with fibromyalgia and physical therapists. They contributed throughout the design process, from the identification of needs to the development of the prototype and its validation. Thus, it was possible to minimize the risk of the application not meeting the needs of these people as well as helping to make it easy and intuitive to use, thus enhancing its approval and success.

6.2. Future work

Although the solution that was developed already fulfills its main purpose, it is not a finished work since it is part of a much larger project that involves quite a few people.

Before continuing with further development, more usability tests should be performed, thus having a larger number of participants in order to have more reliable results and paying more attention to observation metrics such as mistakes made or requests for help. In addition, tests in a more realistic environment and for a longer period should be made, i.e., without the presence of the development team around and with the participants using the application as part of their daily lives. This should allow the research team to acquire more insights by enabling the identification of possible errors and doubts that in a closed environment would hardly ever happen.

As stated in section 3.2.4, there was no consensus on which way the solution should be used (mobile or web application). Since the functionality in the first phase of the solution would be more beneficial to be used through a mobile application, this was developed first. Therefore, in the future a new version of the application should be available in order to be used via a web browser. It is expected that this new version will be quick to develop due to the use of the Flutter technology that allows through the same code base to generate a web/mobile application. Through this web version it will be easier for some people to conduct remote sessions, since they can use a desktop or laptop computer that has a larger screen than a mobile device.

At this moment only the patients can use the solution, however the aim of the solution is that the physical therapists also have an area where they can manage their patients. Therefore, a dedicated application, or the same application with extended features for the physical therapists will be necessary. After this part is completed there will be a first version of the solution ready to be used in a real context.

When the supporting solution is ready to be used by the physical therapists, new versions can be developed from some of the ideas that emerged during the process and that were not implemented because they were not a priority. The community component was a point that was previously discussed that could lead to the inclusion of a friendship system where people can add themselves to better communicate, and to share their experiences and achievements in a common friends feed.

Another idea that emerged was the possibility of the application automatically counting the distance travelled by people as they completed the suggested walks in the group's

challenges. In this way, people would not have to manually register in the application the traveled meters, thus providing a better user experience. In addition, so that people could use the solution in a more autonomous way, it was thought about providing patients the questionnaires they usually answer in some sessions, so that they could fill them out by themselves and when they felt the need to do so, thus obtaining the results of the indicators (Fatigue, Health Status, Pain and Sleep) without always depending on the physical therapist.

Finally, this solution has as a fundamental component the realization of remote sessions, through a video call service. As said in section 4.2.1, the Jitsi public servers are being used for these video calls, and although this service does not have any cost or other inconvenience, it would be important to place it in a server managed by the team, so that the this feature would not be overly dependent on this third-party service.

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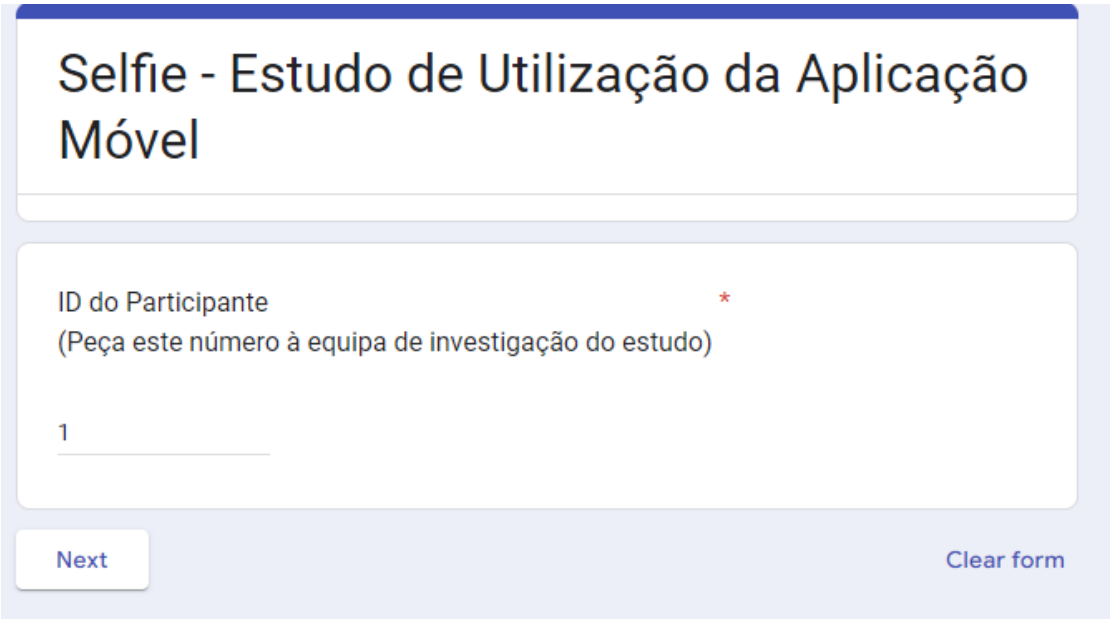
Appendix A

Questionnaire questions

A.1 Section 1 question



A.2 Section 2 - Demographics questions

Dados Pessoais

Nesta secção são recolhidos alguns dados pessoais para efeitos de caracterização.

Idade *

A sua resposta

Género *

- ◯ Masculino
- ◯ Feminino
- ◯ Prefiro não responder
- ◯ Outra:

Nível de Escolaridade *

- ◯ Ensino Básico (1º Ciclo)
- ◯ Ensino Básico (2º Ciclo)
- ◯ Ensino Básico (3º Ciclo)
- ◯ Ensino Secundário
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento
- ◯ Prefiro não responder
- ◯ Outra:

A.3 Section 3 – Diagnose information questions

Fibromialgia

Nesta secção deverá responder a algumas questões relativas ao seu diagnóstico e tratamento da fibromialgia.

Há quanto tempo lhe foi diagnosticada Fibromialgia (em anos)? *

A sua resposta

Toma alguma medicação para as queixas associadas à fibromialgia? *

- ◯ Sim
- ◯ Não
- ◯ Prefiro não responder

Pratica exercício físico de forma regular? *

- ◯ Sim
- ◯ Não
- ◯ Prefiro não responder

Caso pratique exercício físico, qual é o tipo de exercício que pratica?

A sua resposta

Caso pratique exercício físico, com que frequência o faz (número de vezes por semana)?

- ◯ 1

- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ Prefiro não dizer
- ◯ Outra: _____

Que importância atribui ao exercício físico? *

	0	1	2	3	4	5	6	7	8	9	10	
Nada importante	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremamente importante

Quão confiante se sente para realizar exercício? *

	0	1	2	3	4	5	6	7	8	9	10	
Nada confiante	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremamente confiante

A.4 Section 4 – Technology questions

Tecnologias de Informação

Nesta secção deverá responder a algumas questões relacionadas com a sua experiência com as tecnologias de informação.

Indique quais dos seguintes dispositivos possuí:

- [ ] Telemóvel (não Smartphone)
- [ ] Smartphone
- [ ] Tablet
- [ ] Smartwatch
- [ ] PC (Portátil ou Secretária)
- [ ] Outra: _____

Se possuí smartphone (ou tablet), qual é o sistema operativo?

- ( ) Android (esmagadora maioria das outras marcas)
- ( ) iOS (iPhone/iPad)
- ( ) Não sei
- ( ) Prefiro não responder
- ( ) Outra: _____

A.5 Section 5 – Scenarios questions

Aplicação Selfie

Indique o grau de concordância com cada uma das afirmações.

Considero que a implementação atual da funcionalidade dos "desafios de grupo" está adequada para promover a motivação para a realização de exercício físico. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero que a implementação atual do *"chat"* está adequada para promover um contacto próximo com o fisioterapeuta. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero que a implementação atual da funcionalidade de "vídeo-chamada" está adequada para suportar a realização de sessões remotas. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero que a disponibilização de opções de realização para sessão autónoma são adequadas. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero que a disponibilização de opções de realização para sessão autónoma são adequadas. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero que a implementação atual da funcionalidade de "informações relativas a indicadores de saúde" é adequada para suporte à auto-gestão da doença. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considero as "informações relativas a indicadores de saúde" são relevantes. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

A.6 Section 6 – Usability questions

Escala Usabilidade do Sistema

Indique o grau de concordância com cada uma das afirmações.

Acho que gostaria de utilizar a aplicação Selfie com frequência. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considerei a aplicação Selfie mais complexa do que necessário. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Achei a aplicação Selfie fácil de utilizar. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Acho que necessitaria de ajuda de um técnico para conseguir utilizar a aplicação Selfie. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considerei que as várias funcionalidades deste a aplicação Selfie estavam bem integradas. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Achei que a aplicação Selfie tinha muitas inconsistências. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Suponho que a maioria das pessoas aprenderia a utilizar rapidamente a aplicação Selfie. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Considerei a aplicação Selfie muito complicada de utilizar. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

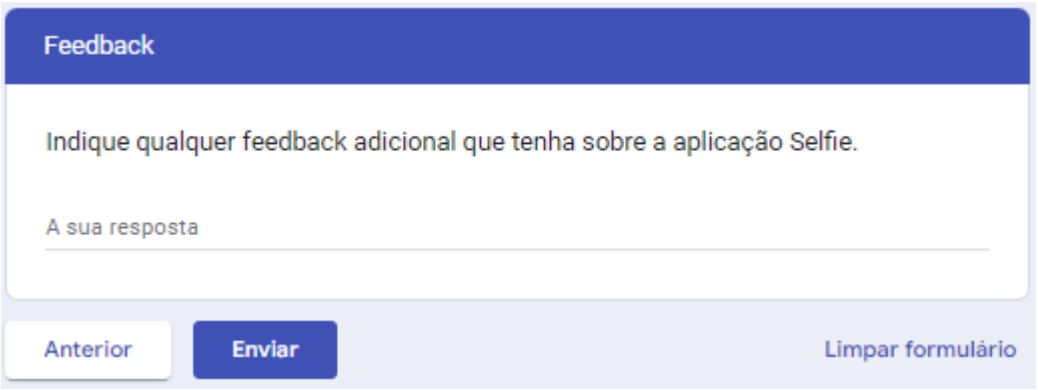
Senti-me muito confiante a utilizar a aplicação Selfie. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

Tive que aprender muito antes de conseguir lidar com a aplicação Selfie. *

	1	2	3	4	5	6	7	
Discordo totalmente	○	○	○	○	○	○	○	Concordo totalmente

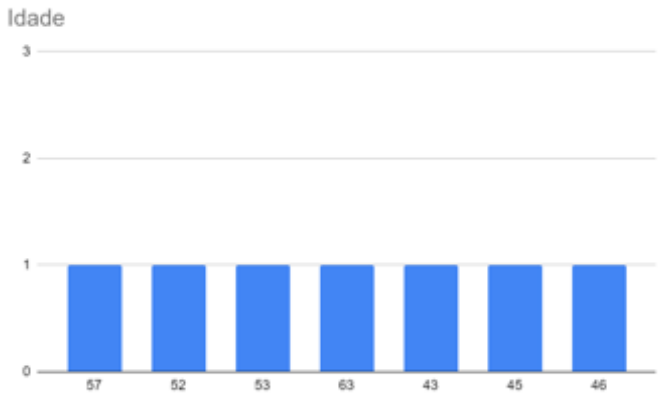
A.7 Section 7 – Additional feedback

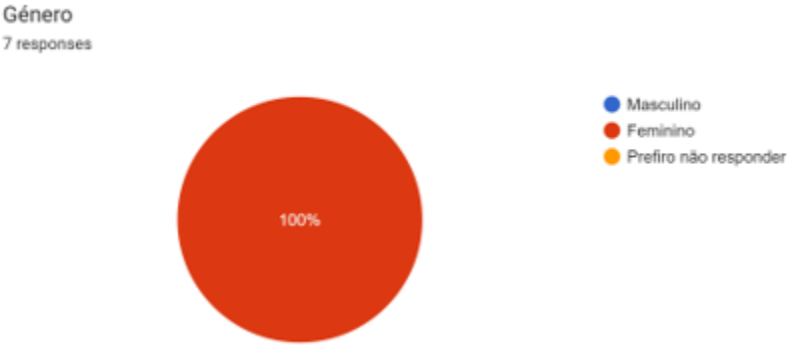


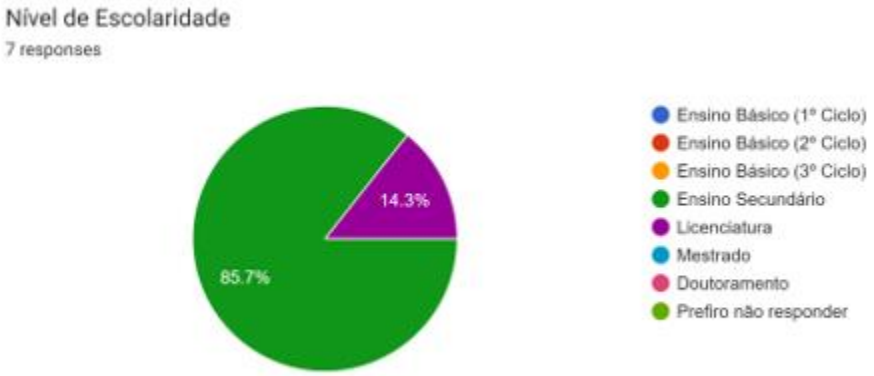
Appendix B

Questionnaire results

B.1 Section 2 - Demographics questions results



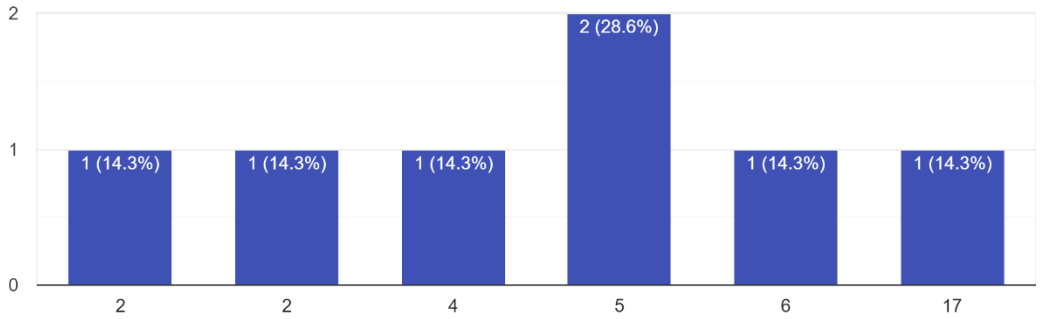




B.2 Section 3 - Diagnose information questions results

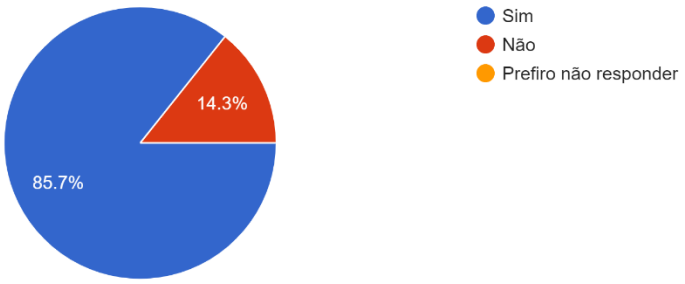
Há quanto tempo lhe foi diagnosticada Fibromialgia (em anos)?

7 responses



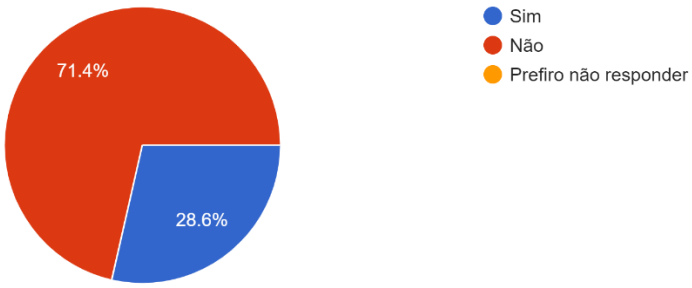
Toma alguma medicação para as queixas associadas à fibromialgia?

7 responses



Pratica exercício físico de forma regular?

7 responses



Caso pratique exercício físico, qual é o tipo de exercício que pratica?

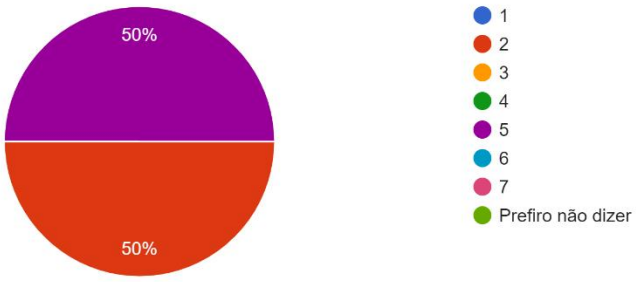
2 responses

hidroterapia

fisioterapia, fisio class e hidroterapia

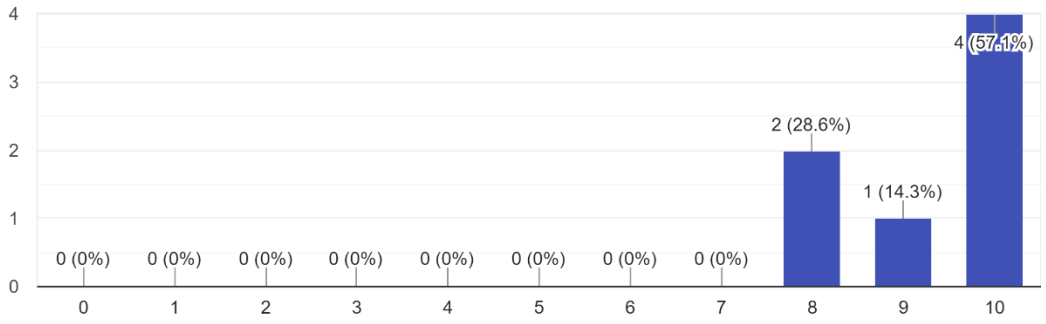
Caso pratique exercício físico, com que frequência o faz (número de vezes por semana)?

2 responses



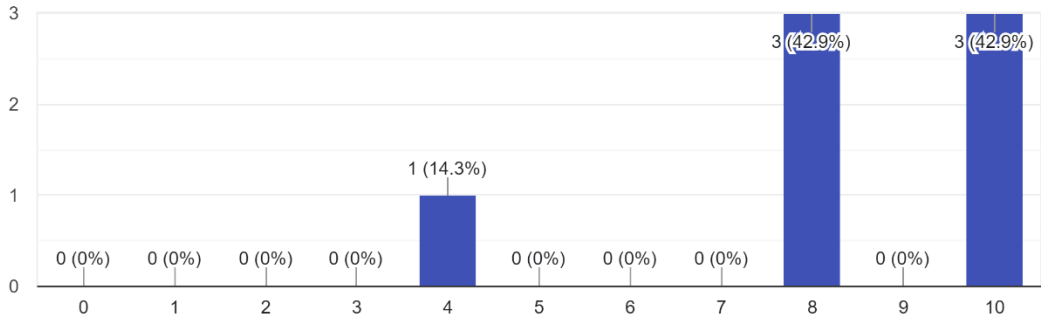
Que importância atribui ao exercício físico?

7 responses



Quão confiante se sente para realizar exercício?

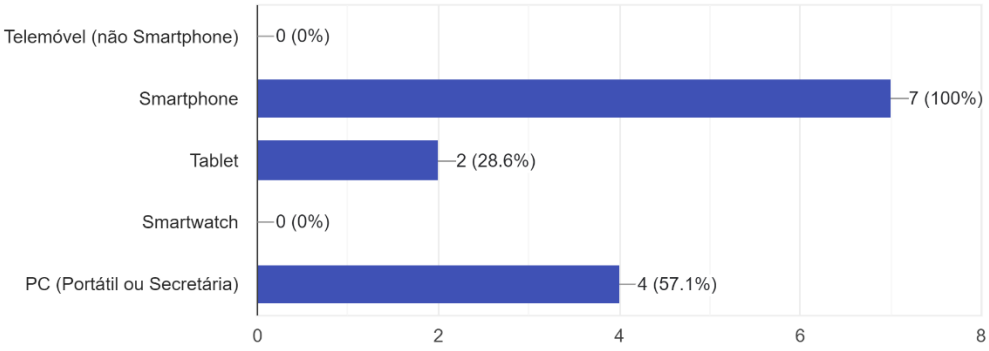
7 responses



B.3 Section 4 - Technology questions results

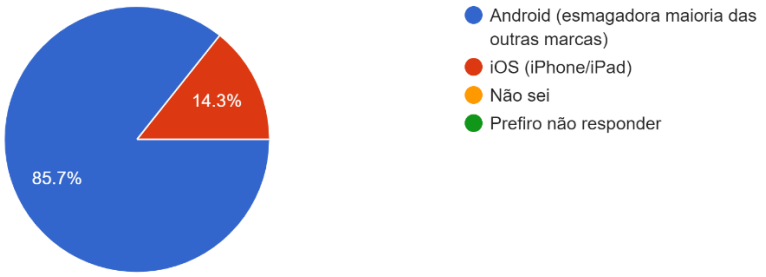
Indique quais dos seguintes dispositivos possuí:

7 responses



Se possuí smartphone (ou tablet), qual é o sistema operativo?

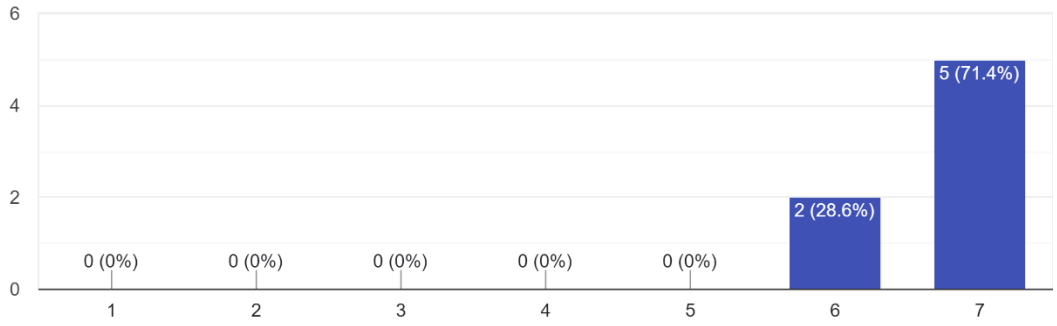
7 responses



B.4 Section 5 – Scenarios questions results

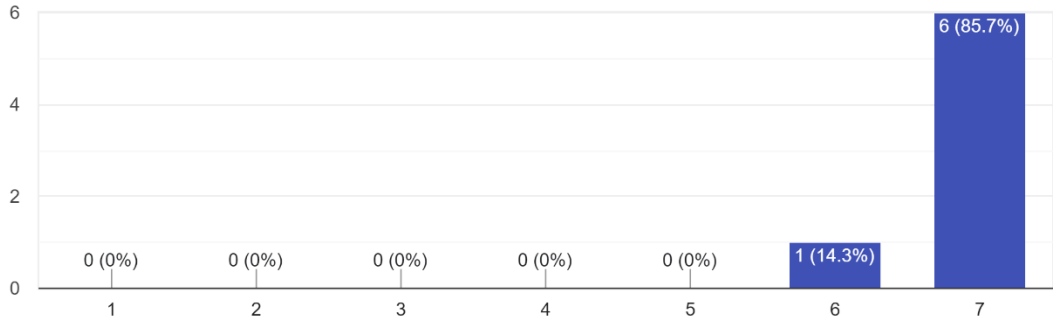
Considero que a implementação atual da funcionalidade dos "desafios de grupo" está adequada para promover a motivação para a realização de exercício físico.

7 responses



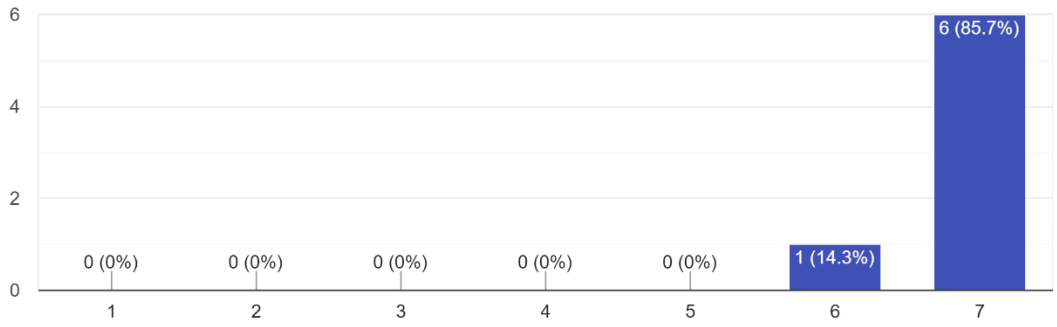
Considero que a implementação atual do "chat" está adequada para promover um contacto próximo com o fisioterapeuta.

7 responses



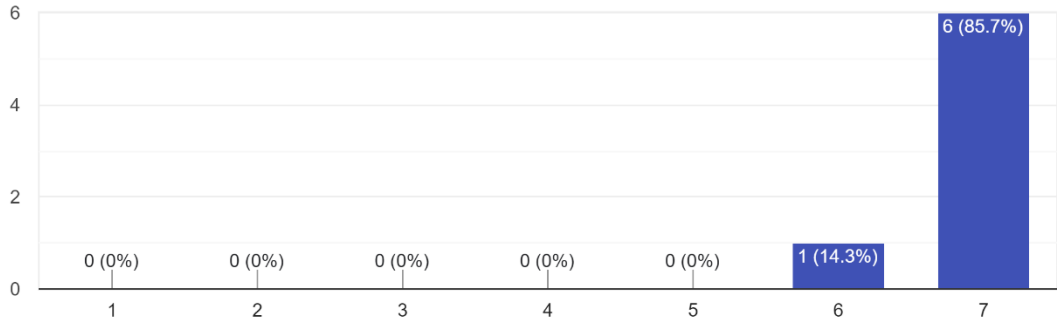
Considero que a implementação atual da funcionalidade de "vídeo-chamada" está adequada para suportar a realização de sessões remotas.

7 responses



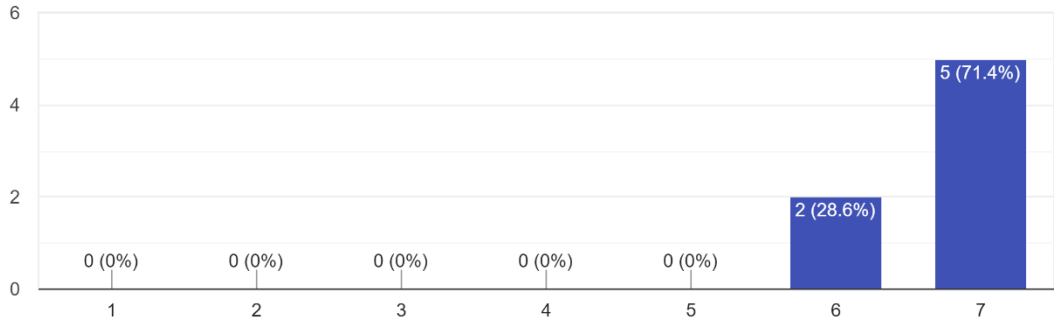
Considero que a disponibilização de opções de realização para sessão autónoma são adequadas.

7 responses



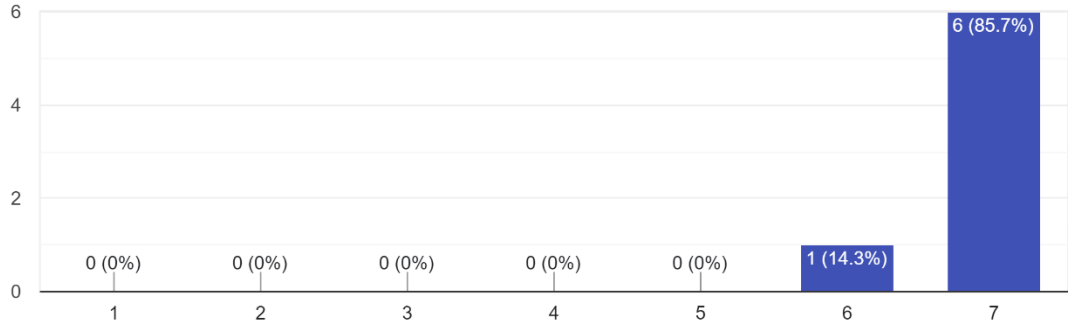
Considero que a implementação atual da funcionalidade de "informações relativas a indicadores de saúde" é adequada para suporte à auto-gestão da doença.

7 responses



Considero as "informações relativas a indicadores de saúde" são relevantes.

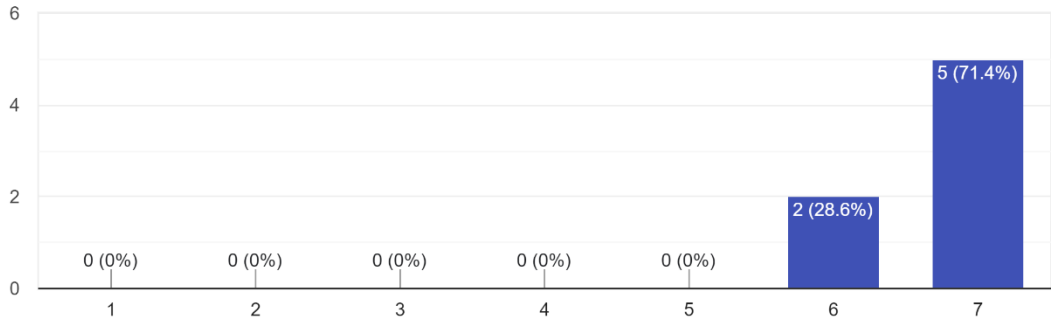
7 responses



B.5 Section 6 - Usability questions results

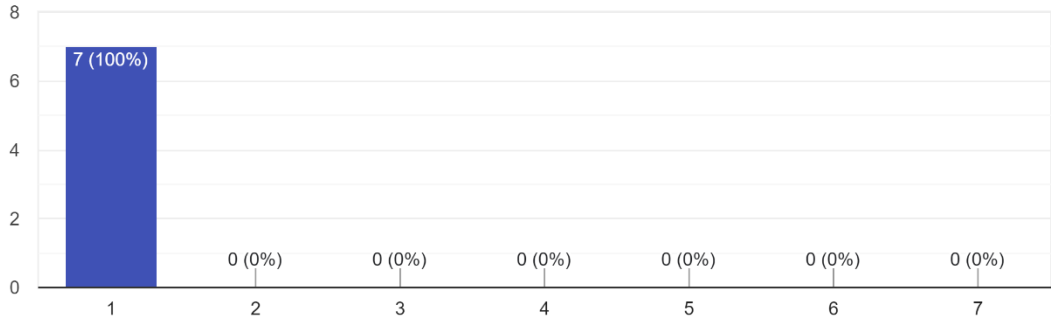
Acho que gostaria de utilizar a aplicação Selfie com frequência.

7 responses



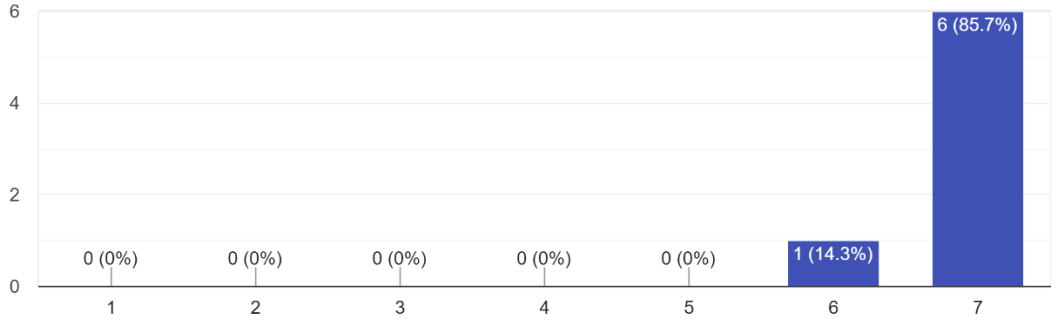
Considerei a aplicação Selfie mais complexa do que necessário.

7 responses



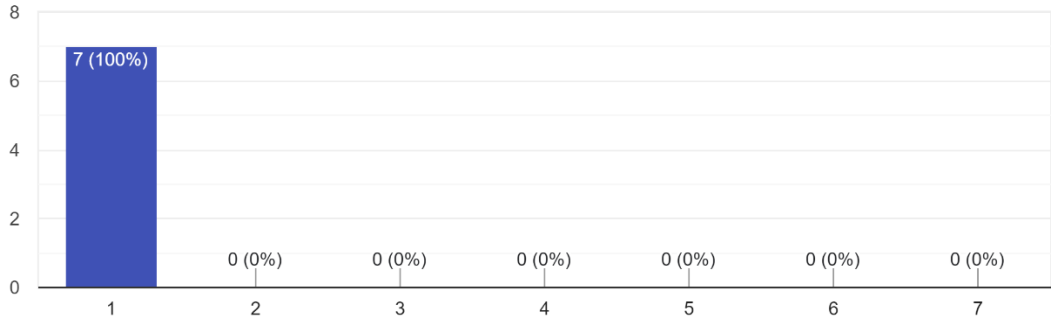
Achei a aplicação Selfie fácil de utilizar.

7 responses



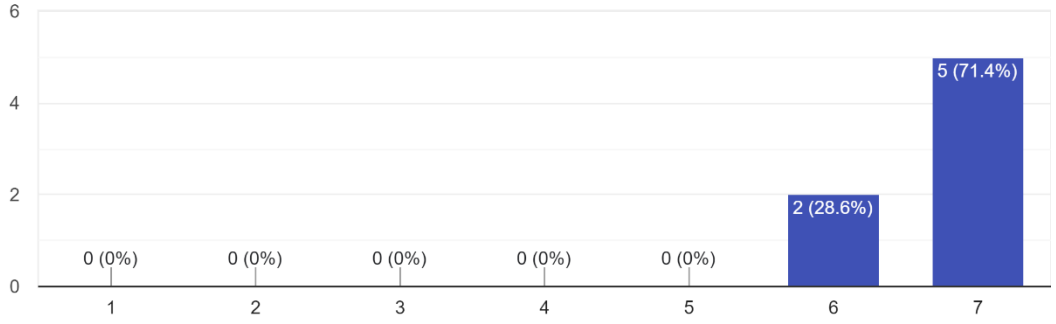
Acho que necessitaria de ajuda de um técnico para conseguir utilizar a aplicação Selfie.

7 responses



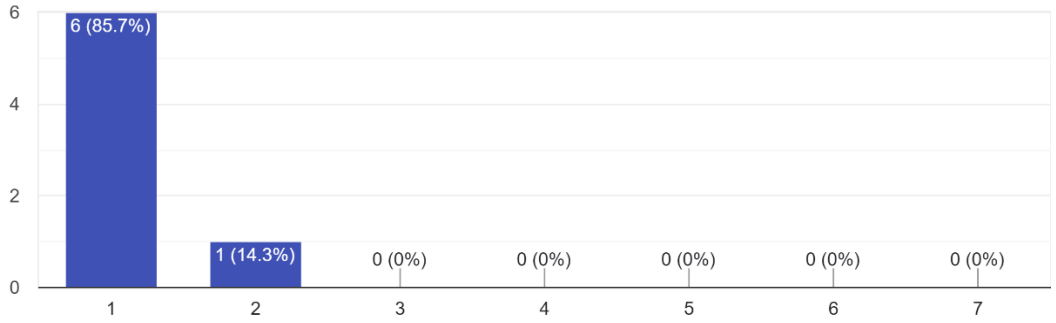
Considerei que as várias funcionalidades deste a aplicação Selfie estavam bem integradas.

7 responses



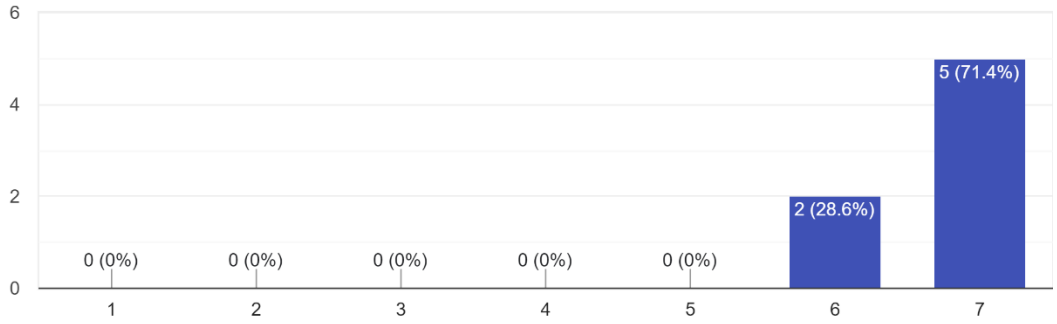
Achei que a aplicação Selfie tinha muitas inconsistências.

7 responses



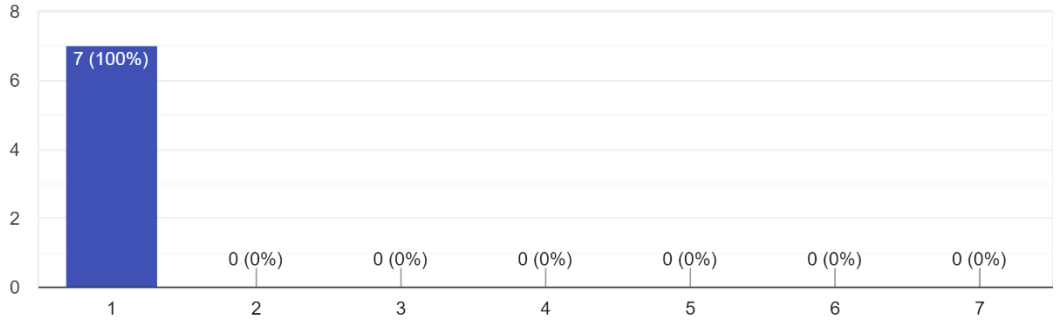
Suponho que a maioria das pessoas aprenderia a utilizar rapidamente a aplicação Selfie.

7 responses



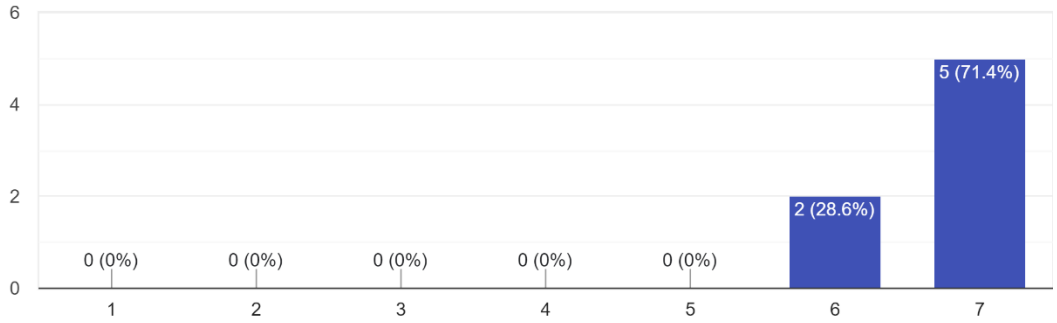
Considerei a aplicação Selfie muito complicada de utilizar.

7 responses



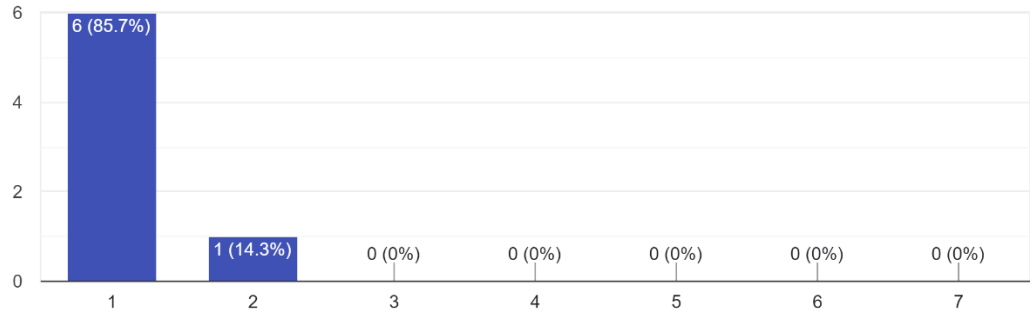
Senti-me muito confiante a utilizar a aplicação Selfie.

7 responses



Tive que aprender muito antes de conseguir lidar com a aplicação Selfie.

7 responses



B.6 Section 7 – Additional feedback results

Indique qualquer feedback adicional que tenha sobre a aplicação Selfie.

3 responses

Penso que é uma mais vai para nós

Acho que a aplicação deveria registar o nº de passos automaticamente

Na minha opinião está tudo perfeito