MASTER THESIS
Mater of Science in Design and Innovation

DESIGN OF AN APP FOR STUDENTS TO MANAGE THEIR MENTAL HEALTH

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Kongens Lyngby, January 2022

TECHNICAL UNIVERSITY OF DENMARK
DEPARTMENT OF DESIGN AND INNOVATION

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Summary

General health and in particular mental health amongst young has become of increasing topic of interest. The latest report from the Danish Health Authorities (Sundhedsstyrelsen) about The National Health Profile (Den Nationale Sundhedsprofil) (Sundhedsstyrelsen, 2017) found that for Danes, "health is moving in the wrong direction". There are significant problems with obesity, mental health, stress, anxiety, depression, loneliness, smoking, and alcohol intake amongst in particular young people.

The recent COVID-19 pandemic has increased the demand for mental health services and triggered mental health conditions or exacerbated existing ones like isolation, bereavement, loss of income, and fear (WHO, 2020). This has motivated an increasing awareness in universities regarding students' mental health.

Furthermore, treatment of patients lacks continuous data gathering, and it is summarized in a few consultations separated in time, which makes it difficult for clinicians to get a better picture of what has the patient being going through during that period.

A mobile application has been designed with the aim of helping students manage their mental health. Creating a setup in which all the stakeholders involved in students' mental health are connected, in order to provide new forms of intervention enabled by technology to promote healthy living as well as help students modulate their behavior.

The design process included a User-Centered Design (UCD) methodology in order to design an app that is helpful and engaging for the students, while it remains a useful tool for health professionals to better understand and assess mental health in students. Mental healthcare professionals and students are the stakeholders involved in the process, mainly through interviews.

Preface

This master thesis was prepared at the Department of Design and Innovation at the Technical University of Denmark in fulfillment of the requirements for acquiring a Master's Science degree in Design and Innovation. The report describes the thesis project completed in the fall of 2021, corresponding to 30 ECTS-points. The content of this thesis is meant to be understood by a broad audience.

The thesis was developed in the Copenhagen Center for Health Technology (CACHET), where the author was employed as a student assistant. And it was co-supervised by Jaap Daalhuizen (DTU) and Jakob Eyvind Bardram (CACHET & DTU).

Kongens Lyngby, January 2022

Gonzalo Pérez Jiménez


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And finally, to my family, who supported me during my time in Denmark.

Contents

1. Introduction

1.1 Background

General health and in particular mental health amongst young has become of increasing topic of interest. The latest report from the Danish Health Authorities about The National Health Profile (Den Nationale Sundhedsprofil) found that for Danes, "health is moving in the wrong direction" (Sundhedsstyrelsen, 2017). There are significant problems with obesity, mental health, stress, smoking, and alcohol intake amongst, in particular, young people.

This has spun significant political debate regarding mental health amongst students. Problems such as stress, anxiety, depression, and loneliness are commonly found in students.

The recent COVID-19 pandemic has increased the demand for mental health services and triggered mental health conditions or exacerbated existing ones like isolation, bereavement, loss of income, and fear (WHO, 2020). This has motivated an increasing awareness in universities regarding students' mental health.

According to Danmarks Evalueringsinstitut, out of the 270.000 students in Denmark, the number of them suffering from one or more of the above-mentioned conditions during 2019 is estimated to be 20%, above 50.000 students. However, the number of students that are currently receiving help from health-related institutions stays at 5.000 (EVA, 2019). This number is expected to grow up to 6.000 in 2020 due to the effects of the pandemic.

This big gap provides justification to the project and sets the aim to deliver a solution to the remaining 45.000 students, encouraging them to take action regarding their mental health and supplying them with useful and hassle-free tools. While providing mental health institutions and professionals with a tool that will provide them with useful data to better understand the mental health issues faced by the students and potentially reduce the mentioned gap without overflowing the mental healthcare systems.

Furthermore, the traditional treatment of patients lacks continuous data gathering, and it is summarized in a few consultations separated in time, which makes it difficult for clinicians to track the patients' wellbeing during that period.

Using digital solutions like smartphones to collect real-time data about students' wellbeing is rising as a response to the continued growth in the demand for mental healthcare.

1.2 Thesis

The main objective for this thesis will be to **Design an App for Students to Help them Manage their Mental Health**. To do so, the project will be aiming to create a setup in which all the stakeholders involved in students' mental health are connected, in order to provide new forms of intervention enabled by technology to promote healthy living as well as to help students modulate their behavior.

Taking the StudentLife study (see *2. Clinical background and related work*) as a starting point, in terms of methods employed and technology used, the focus will be to reformulate

it with a user-centered approach: design an app that is helpful and engaging for the students, while it remains a useful tool for health professionals to better understand and assess mental health in students.

In this sense, the main problem to face will be to understand the process of student mental health management and the role that an app can have in that process.

In order to successfully solve this problem, some related sub-problems will have to be solved:

- Understand what are the most common mental health problems amongst students along with their symptoms and treatments.
- Understand what values are useful to collect both with automatic sensing and manual input.

1.3 Research Goals and Methods

The goals to be achieved during this project are the following:

- Design a user-friendly app, employing a user-centered design involving the different stakeholders of students' mental health throughout the process, testing the prototypes and iterating from the results obtained in those tests. For this purpose, it will also be important to understand and follow the guidelines for the design of health-related apps. Another critical point is to engage students in the app by providing useful feedback, understanding the reasons that lead a patient to drop out, and avoiding them.
- Design for data collection, research about the different types of data that can be collected and their use case, interviewing clinicians and understanding what data is useful for them to be collected, both by automatic sensing from a mobile device and by manual input by the user.

1.4 Empirical Considerations

Prior to the start of the project, the following empirical considerations were stated:

- The final outcome from this project will be a detailed user experience design and user interface ready to be coded and clinically tested.
- The users for the app in this project will be students from DTU with different backgrounds.
- The project will be developed in collaboration with COPENHAGEN CENTER FOR HEALTH TECHNOLOGY (CACHET). Additionally, I plan to collaborate with mental healthcare professionals in Denmark and Spain.
- All the resources in terms of software and hardware needed for the project will be provided by CACHET.
- During this project my role will consist of being the UX/UI designer for CACHET. Delivering a solution for students to manage their mental health.

1.5 Impact

The outcome of this project, when completely implemented, will provide an extra tool for health professionals and students to better understand and improve mental health amongst students:

- For health professionals, it will provide continuous data from students with mental health issues. This will help them get a broader picture of the circumstances surrounding these issues. At the same time, they will get a better monitoring of students regarding their mental health.

- For students, it will provide them with a tool to manage their mental health with a continuous assessment based on the data collected.

1.6 Intended Learning Objectives

The Intended Learning Objectives (ILO) of this Thesis are:

- identify and define complex societal needs in order to design products, services, and systems that successfully address those,

- evaluate, transform and integrate design methods to fit design and innovation projects in complex organizational contexts,

- evaluate and reframe design challenges and problems to navigate the needs and interests of various stakeholders of different background,s

- apply user experience and behavioral design theories and methods apply theories of innovation, business strategy, and entrepreneurship to design project,s

- manage multiple stakeholders and priorities in design and innovation processes,

- plan, manage and execute multi-disciplinary design team working in a range of areas,

- transfer technology knowledge into design projects,

- understand and apply the guidelines for a design of a health-related app,

- and carry a user-centered design process.

1.7 Report Overview

The process followed during the design of a mobile application with the aim of providing students with tools to manage better their mental health is documented in the report following this order:

- Chapter 1: Introduces the thesis project, describing the background behind the project, the goals to reach, and the methods to achieve them, stating the empirical considerations, the predicted impact, and the intended learning objectives of the thesis.

- Chapter 2: Describes the state of the art of digital health, in particular digital psychiatry and the literature relevant to the project; then analyzes the work done

related to the topic.

• Chapter 3: Describes the design process, depicting the methodology and tools employed during the project. This chapter also displays the plan for the project dividing it into activities, milestones, deliverables, and risks.

• Chapter 4: Introduces the prototyping process by stating the requirements extracted from the problem statement, research and user interviews, and describing the iterations and tests that will result in the final prototype. Lastly, it will describe the use of interventions and data collection in the app,

• Chapter 5: This chapter will discuss the master thesis project, beginning with a personal reflection on the thesis and setting a timeline for the future works in the CampusLife project.

• Chapter 6: The last chapter will conclude the thesis, summarizing the thesis by briefly overviewing the problem statement, process, results, reflection, and next steps.

2. Clinical Background and Related Work

This project aims to provide students with a digital solution to help them improve their mental health. In order to understand the problem domain and explore the field of digital psychiatry, the author conducted research into the topic's existing literature and related work. The research is summarized in this section.

2.1 Clinical Background

Over one billion people around the globe are suffering from mental health problems, being depression the most common cause of disability worldwide (Rehm J, 2019). This represents the main challenge to be tackled by the Mental Health Gap Action Program, part of the World Health Organization (MHGAP, 2020). However, the enormity of the task makes it unfeasible to provide solutions to this problem with traditional in-person mental healthcare, this manifests the need for alternative solutions with the use of new technologies (J. Torous et al., 2021).

The use of telehealth has been growing alongside the technology that enables the development of digital health. However, the recent COVID-19 pandemic has propelled the use of digital health technologies. The use of these technologies offers accessible, affordable, and scalable interventions to complement traditional healthcare (J. Torous et al., 2021).

Digital psychiatry is no exception and has experimented a growth in the demand and use of mobile mental health technologies. Smartphone apps, social media, chatbots, and virtual reality are examples of growing technologies employed for digital mental health. These new technologies are already delivering results and transforming mental health care in new ways, providing a promising evidence base, introducing digital health technologies as a feasible alternative to traditional healthcare for the purpose of reducing the abovementioned gap (J. Torous et al., 2021).

The relevance of recent technological advances to mental health research and care like smartphones, chatbots, virtual reality, social media, and other forms of digitally-delivered psychological therapies, is already remarkable, being used for mood and lifestyle tracking, increasing access to care, exposure therapies, population-level monitoring, and self-management of mental health respectively. However, the project will focus mainly on the use of smartphones for tracking mood and lifestyle data, and self-reported data to provide useful tools and interventions for patients.

Smartphones being portable, wireless, and affordable has gravitated towards being the first device providing internet access to a big percentage of the world's population. In 2018, one out of four citizens of advanced economies owned a smartphone, this percentage is significantly lower in emerging economies (45%) (Silver L., 2019), anyhow, it still represents a high proportion of the human population.

Smartphones - and wearables - offer the possibility of collecting a great variety of passive data from users that can be used to construct health-related features (see Figure 1). To do so, it is needed to interpret what individual or combination of passive data provides what kind of signals related to mental health. Different studies have already looked into the translation of the so-called Digital Phenotyping and the utility of this data for the different mental health conditions (J. Melcher et al., 2020) (J. Rooksby, 2019).

Data collection in smartphones can be classified into active data collection and passive data collection.

Active data collection refers to self-reported measures and it is mainly represented by smartphone-based surveys like mood or questionnaires.

Passive data collection refers to the data collected automatically by the smartphone sensors. The list of smartphone sensors previously used in digital phenotyping research is depicted in Figure 1. Other sensors used but not included in the figure are the camera and the keyboard/UI (J. Rooksby, 2019).

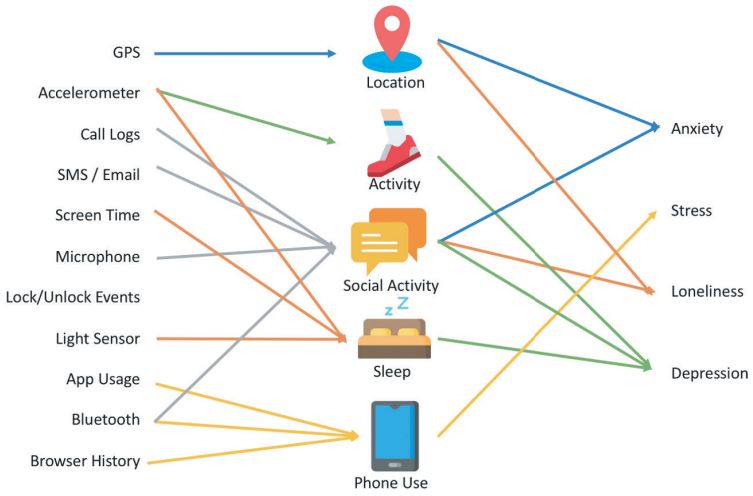


Figure 1: Feature constructions from passive data streams. J. Torous et al., 2020

These two kinds of data collection are commonly combined in recent research, the most relevant example for this project is the StudentLife study, the precursor of this project (see 2.2 Related Work).

There are other relevant examples of studies succeeding in the use of mobile sensing and surveys to monitor patients: a recent study used smartphones to capture rapid fluctuations in individuals with bipolar disorder. This study to monitor mood symptoms in bipolar disorder analyzed the feasibility of using a smartphone to capture the mood fluctuations with self-reported questionnaires and relate them to the activity behaviors reflected by the smartphone sensing. The study proved the use of smartphone technology as a promising way to collect clinical information that can be used for treatment decision-making while remaining relatively hassle-free for patients (KA Ryan et al., 2020).

However, other studies have benefited from the use of smartphones, specifically the use of social media platforms, where people often reflect their mood, thoughts feelings, and activities. Two examples of studies monitored patients ' activity in Facebook and Twitter, two of the biggest social media platforms. In these studies, researchers focused the monitoring into observing social media activity of patients and analyzed the influence of mental disorders, including depression, in the behavior of social media users. The results in both studies proved how users suffering from mental health conditions modify the general characteristics of their language or the way they interact in social media (A Leis et al., 2019) (ML Birnbaum et al.,2019).

Regarding patients, they are becoming more informed and proactive about their mental health care and many are seeking technology-oriented and self-directed treatment options (Alvarez Mon MA, 2021).

However, it has been proven that the interest of patients in this kind of apps decays over time causing dropout. This is an increasingly recognized challenge for health research, as low engagement and dropout hinder interpreting and translating the findings from health-related apps. Research has been conducted to calculate the dropout rates in smartphone apps for patients with depression symptoms, with a result of almost 50% of patients dropping out. This study discussed the possible reasons and strategies to follow in order to lower the dropout rates, highlighting the better rates of apps providing human feedback and mood monitoring (J. Torous et al., 2019).

As mentioned before, digital psychiatry is a still-growing field, and the recent COVID-19 pandemic has increased the use of telehealth and mobile mental health technologies. And educational institutions are no exception: the growth in the demand for mental health services has affected universities internationally. In response to this increasing demand, colleges are seeking digital solutions to increase access to care (J. Melcher et al., 2020).

Recent reports in the USA stating that mental wellbeing is in continued decline (K Eagan, 2017), or in South Korea where the increasing suicide rate is considered to be the hidden price of education (G Chin-Lun H, 2016) are some of the examples of the awareness around the growing issue. It is evident that the increasing suicide rate is a cause for concern. But students with less severe mental health issues should also be a cause for concern, as they are more likely to achieve less, have a lower life quality, and drop out of education (P. Brown, 2016) (J. Rooksby, 2019).

2.2 Related Work

The recent technological advances in mental health research, and care, the new technological capabilities of smartphones, artificial intelligence, social media and virtual reality are already changing mental health care. Thus, the breeding ground set by the pandemic situation has accelerated the process of incorporating new remote interventions. This, added to the emerging efficacy in self-management of psychological well-being represents an opportunity for new kinds of mobile mental health interventions (J. Torous et al., 2021).

In regards to the efficacy of these new kinds of smartphone-based mental health interventions, it has already been proven by researchers as a promising self-management tool for reducing symptoms of depression (J. Firth et al., 2017 I) and anxiety (J. Firth et al., 2017 II). In these studies, smartphone apps for depression and anxiety were analyzed by monitoring the progress of a total of 5.000 patients between both studies, proving that psychological interventions delivered via smartphone devices can reduce depression and anxiety. However, it also showed some other interesting results: the effects from smartphone-only interventions provided slightly better results than the ones involving other human/computerized aspects.

The app to be developed is focused on students, research about the willingness of people to use a smartphone to monitor mental health in the USA (see Figure 2), shows that the age group of people under 30 years old are significantly more interested than other age groups (J. Torous et al., 2014).

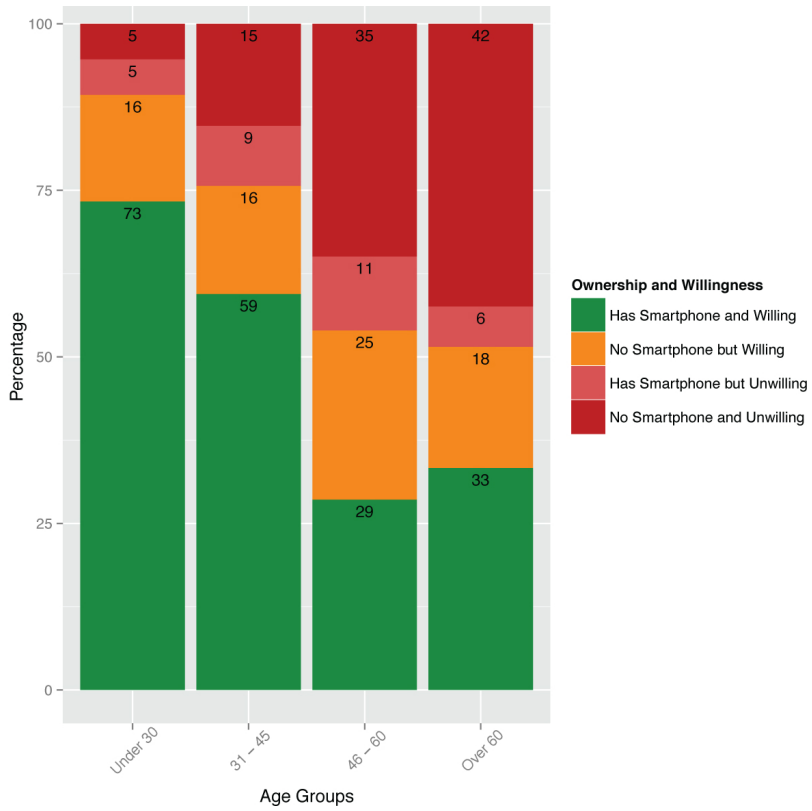


Figure 2: Percent ownership of smartphones and interest in using a smartphone to monitor mental health conditions by age. J. Torous et al., 2014

It seems clear that the youth is the more willing age group to use a mental health app. Furthermore, in terms of actual mental health app downloads and mental health app use, compared to the smartphone ownership percentage, the age group of under 25 highlights again as the group with the highest percentage in all the categories measured (see Figure 3) (J. Torous et al., 2018).

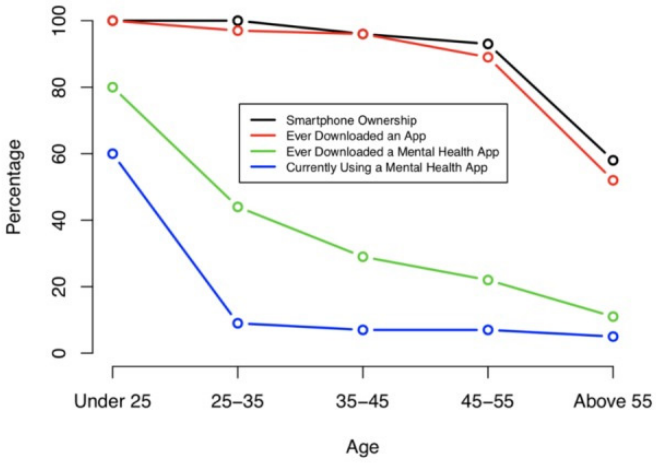


Figure 3: Mobile phone ownership, app downloads, mental health app downloads, and mental health app use reported by private clinic patients. J. Torous et al., 2018

However, the same study showed a low percentage of mental health apps in patients' smartphones, being only the 18th category most present in the smartphones analyzed, being games, social networking, music, and navigation the top four categories (J. Torous et al., 2018). Anyhow, having a mental health app downloaded does not necessarilly translate into the app being used, as mentioned before, engagement is one of the biggest challenges faced in digital psychiatry, and research about the reach, use, and impact of these apps confirms the statement (JE Owen et al., 2015).

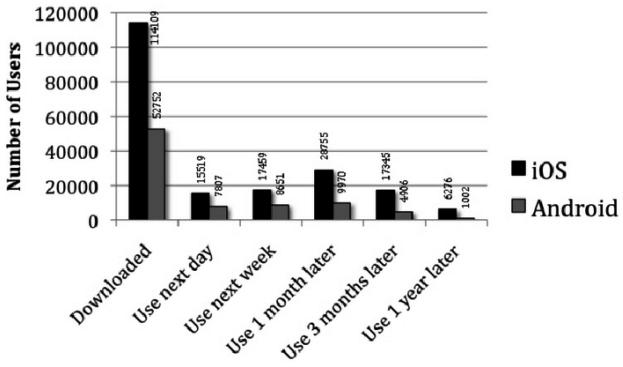


Figure 4: PTSD Coach use and maintenance up to one year after initial download. JE Owen et al., 2015

The project to be developed in this thesis (named CampusLife) will be a continuation of the StudentLife project, the name of an international collaboration that involves universities from the USA, the UK, and EU (R. Wang et al., 2014). This study developed a continuous sensing app to monitor the impact of workload on stress, sleep, activity, mood, sociability, mental well-being, and academic performance on a daily and weekly basis. To do so, they monitored 48 students using Android smartphones during a 10-week deployment corresponding to a complete term at Dartmouth College.

The mobile sensing data collection architecture of the StudentLife Study relied entirely on the automatic continuous sensing of the accelerometer, microphone, light sensor, GPS signal, and Bluetooth. To measure automatically, without any human interaction, the following behaviors (Dartmouth College, 2013):

- Sleep: bedtime, wake-up time, and sleep duration.
- Sociability: the number of conversations and duration of each conversation per day.
- Physical activity: walking, sitting, running, standing.
- Location: where they were located and how long they stayed there (i.e., dorm, class, party, gym).
- Isolation: the number of people around a student throughout the day.
- Mobility: outdoor and indoor campus buildings.
- Stress: level of stress through time.
- Self-esteem: how good they felt about themselves.
- Screen time and app usage.

- Eating habits: when and where they ate.
- In-situ comments on campus and national events.

The results obtained in the research showed significant correlations between the data obtained from the smartphone sensing and mental health and academic performance of the students. However, the StudentLife study did not provide any feedback to students to help them improve their mental health since focusing on the privacy issues to resolve was considered to be out of the scope. Nevertheless, it provided a solid ground to further develop the concept of adding mobile aided interventions guided by professionals on students' mental health.

At the Technical University of Denmark (DTU), the institution in charge of students' mental health is the Student Council, namely Studenterrådgivningen (SRG). They already work with digital solutions provided by third parties like MindDistrict, where students can complete modules recommended by the counselors or complete other kinds of activities.

Outside the academic environment, there already exist plenty of popular alternatives in terms of mental health apps. However, the popularity and ratings of these mental health apps do not always correlate with clinical evidence or even to the results obtained by the users. Recent research regarding the quality, effectiveness, and attributes of top-rated smartphone health apps provided useful insights to understand the actual status of the mental health app environment (H. Wisniewski et al., 2019). In this study, after analyzing 120 mental health apps, the percentage of apps showing specific evidence to support the medical claims was surprisingly low as shown in Figure 5.

Table 1 App star ratings, attributes and medical claims/data by target disease

	Anxiety (n=40)	Schizophrenia (n=40)	Depression (n=40)	Diabetes (n=40)	Addiction (n=40)	Hypertension (n=40)
User star ratings	4.29	4.18	4.41	4.35	4.44	4.10
Presence of a privacy policy	85%	50%	85%	85%	70%	45%
Ability to delete data	70%	20%	70%	60%	45%	25%
Costs associated with the app	70%	15%	65%	40%	65%	60%
Days since last update	58	462	139	37	166	687
Medical claims by app	15%	30%	45%	45%	5%	45%
Specific evidence to support medical claims	5%	10%	0%	5%	0%	0%

Figure 5: App star ratings, attributes and medical claims/data by target disease. H. Wisniewski et al., 2019

To tackle this, mental health organizations like the prestigious American Psychiatric Association (APA) offer app evaluation models to rate mental health apps (APA, 2021). App developers and mental health professionals can benefit from this model and follow the established guidelines to provide patients with the best app possible.

Out of the existing repertoire of mental health apps, these are some examples of the most popular ones that have been tried out by the author for research purposes: Headspace, Intellect, Fabulous, and Habio. In general terms, the experience was positive, bearing in mind that the use of this app was purely experimental and did not last as long in time as it is supposed to.

Intellect is based on behavioral change, offering the user new ways to work on their habits and behaviors. It claims to be backed by psychologists and behavioral experts, delivering a new form of psychological training. Based on the experience as a user, the app was highly customizable, providing useful tips and modules for the users to improve in the selected areas.

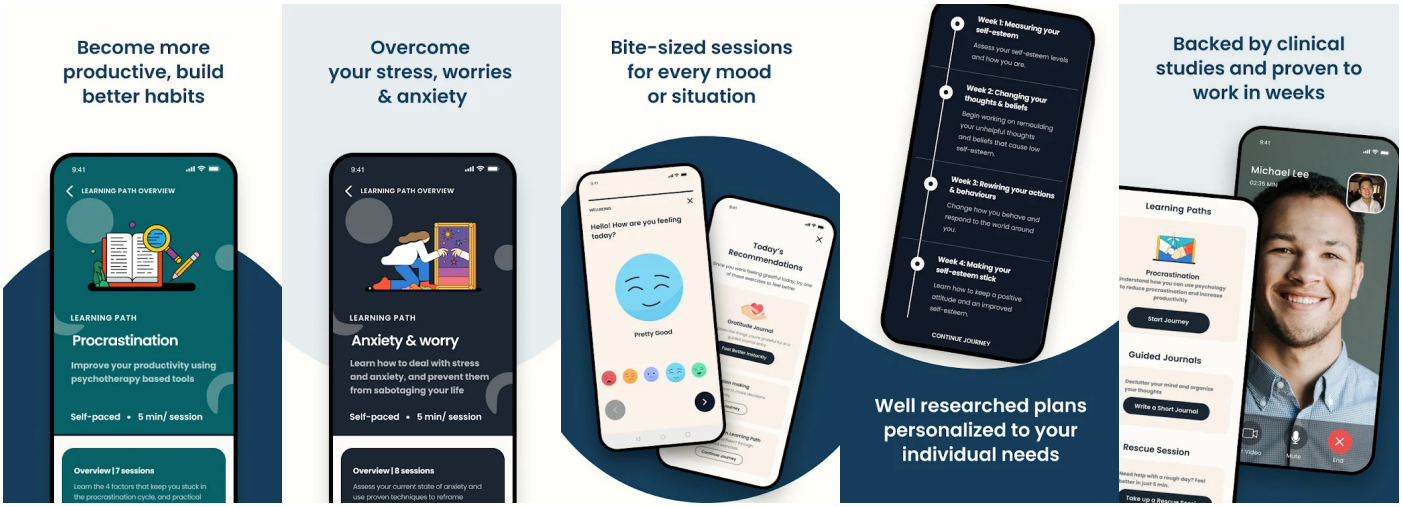


Figure 6: Intellect app. Play Store

Fabulous is an app developed by the Duke University Behavioral Economics Lab. Claims to be a science-based app useful to motivate users toward their wellbeing goals by building routines and picking up life-changing habits. Based on the experience as a user, the app helped create highly customizable routines to get rid of meaningless activities and provoke a sense of achievement.

Figure 7: Fabulous app. Play Store

The Habio also claims to help the user to build new habits while offering a journal to improve personally and modules about wellbeing. Based on the experience as a user, it provided the same main tool as Fabulous, however, Habio focuses more on the numbers, statistics, and scores meant to motivate the users and trigger the sense of achievement.

Figure 8: Habio app. Play Store

Above all of them, the most popular mental health app is Headspace, focusing on meditation and sleep. This app claims to teach users how to relax, manage stress and focus their energy depending on each level in three minutes sessions. The experience as a user is positive from the beginning, with an attractive user interface design.

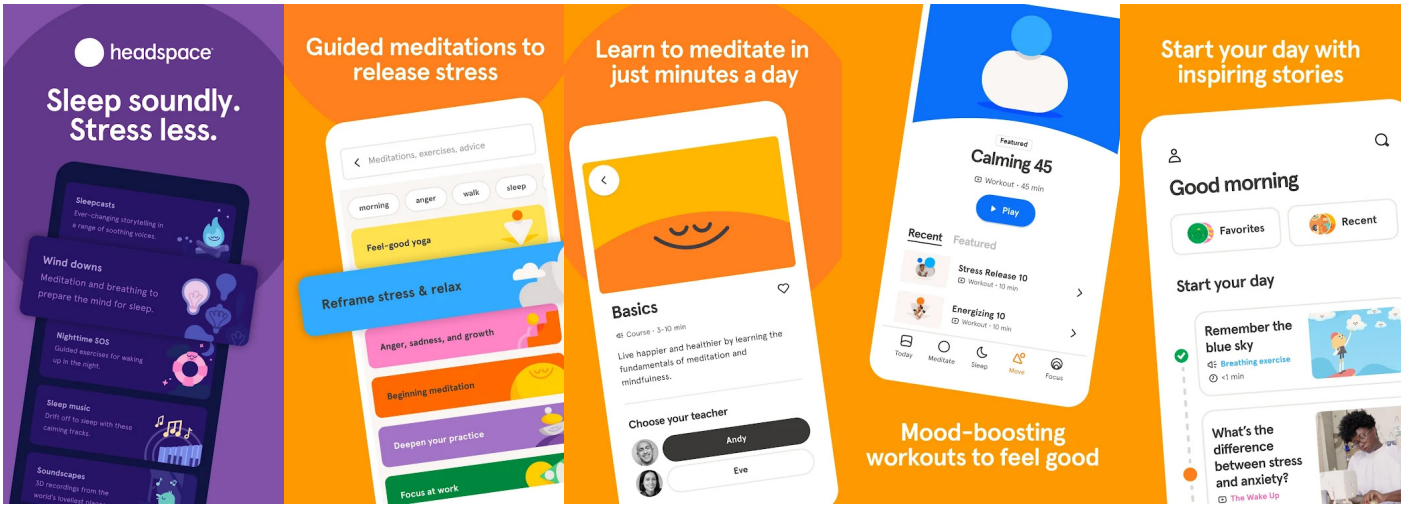


Figure 9: Headspace app. Play Store

However, in relation to apps incorporating aspects of mindfulness, research shows that it does not affect significantly study effect sizes (J. Firth et al., 2017 l). Furthermore, a second research focused only on the Headspace app showed that after completing 30 guided mindfulness sessions, no evidence was found in the users to suggest that engaging in guided mindfulness practice for 6 weeks improves critical thinking performance (C. Noone et al., 2018).

Overall, the research of existing solutions provided a more complete overview of the mental health app panorama and provided a better understanding of the features commonly employed by these apps, their strengths, and their weaknesses.

3. Design Process

3.1 Design Methodology

The design methodology chosen for this project represents the outcome of the author's professional experience and the knowledge acquired during the Design and Innovation Master. The process has been approached by combining the Double Diamond method, the User-Centered Design method, and the Agile Development method. For the iterations during the prototyping phase, the Build-Measure-Learn method was applied. For the thesis writing and development, the Fish Model was applied.

User-Centered Design

Shared by User-Centered Design and the Lean Startup method, this methodology was followed during the thesis.

Figure 10: UCD diagram

The *empathize* phase represents the research on the topic, the documentation read, and interviews with stakeholders (students and mental healthcare professionals).

The *define* phase consisted in setting the focus on the problem we wanted to target, the one we thought we were better positioned to solve. This phase also involved identifying the market needs and the environment into which it would fit better, as well as making the personas to target the solution. Examples of tools used in this phase are Personas and the Stakeholder Map, whivh helped define the users to target and the space solution.

The *ideate* phase involved brainstorming and in-depth interviews with stakeholders to start shaping the solution. A user journey map is another example of a design tool employed during this phase to get a more detailed overview of the space available for the solution in terms of the process of a student suffering from a condition related to their mental health, to define at what stage of the process will the students arrive at the use of the app.

The *prototyping* phase, together with the *test* phase involved three prototype iterations and three different tests to shape a better and tailor-made solution for students and mental healthcare professionals. For this matter, as mentioned below, the *Build-Measure-Learn* cycle was used. An example of a design tool used during this phase is the user story map.

Double Diamond model

The double diamond methodology proved to be a useful tool to set the pace and phases of the project. It divided the project into two divergent phases and two convergent phases. The divergent phases, *discover* and *develop*, are used to broaden and explore the solution space while the convergent phases, *define* and *deliver*, are used to take action and make decisions (Design Council, 2014).

The diverging phases of the diamond represented the exploration, problem identification, and understanding first (discover), and the development of the initial concepts, answers and in-paper sketches second (develop).

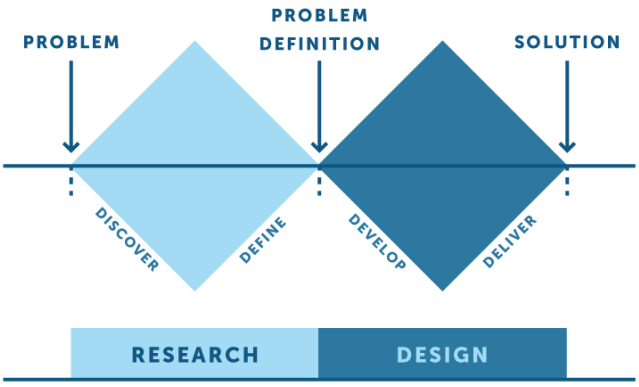


Figure 11: Double Diamond diagram

While the converging phases were used to set the focus and the problem definition first (define) and to iterate the prototype until the final solution second (deliver).

Agile Development

Weekly meetings alternating Jakob and Jaap as supervisors settled a suitable environment to carry an agile development. As the supervising sessions consisted of presenting the work done in the past two weeks, receiving feedback, and setting objectives for the next meeting, it allowed the project to be agile, dividing it into small sprints that will be reviewed biweekly.

Figure 12: Sprint view

This methodology enables teams to deliver value faster, with greater quality and predictability, and greater aptitude to respond to change (A. Srivastava, 2017). If to compare to a SCRUM model, in this case, the mental healthcare professionals will represent the client, supervisor Jakob will be the Product Owner (PO), supervisor Jaap will represent the Scrum Master (SM), students will be the users, and I will represent designer in a Scrum Development Team (SDT).

Build - Measure - Learn Cycle

During the prototyping phase, the Build-Measure-Learn cycle was employed. A total of three iterations were made, described in *Chapter 4: Prototype*.

This method works as a feedback loop, in this case, the feedback will be provided by the stakeholders' interviews, and the author will be in charge of extracting the learnings out of it. This cycle is considered one of the core components of the Lean Startup methodology, and its goal is to turn uncertainties, assumptions, and risks into knowledge that will eventually guide organizations and businesses towards progress. When carrying a project through this process, the key unknowns can actually be transformed into knowledge to be used in product development (A. Belyh, 2019).

After building an iteration of the prototype, this was tested with students and mental healthcare professionals. During this process, other relevant feedback sessions were included (see 3.2.3 Other Feedback Sessions). This continuous cycle of building, testing, and learning gravitated to a more dynamic project and a more accurate solution.

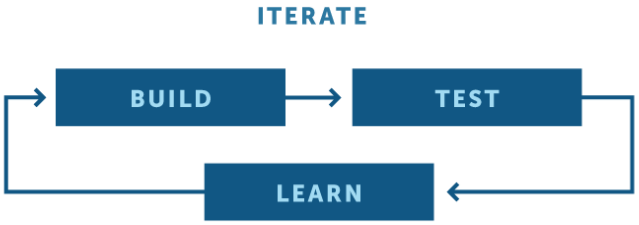


Figure 13: Build - Measure/Test - Learn cycle iteration

Fish Model

For the thesis flow, in terms of finding the right balance between the theoretical part of the thesis and the empirical part, the Fish Model (Jakob E. Bardram, 2007) was followed.

Initially designed for Ph.D.'s, this model can easily be adapted to the MSc thesis. This was done under de supervision and recommendations of Jakob E. Bardram, author of the model and cosupervisor of this thesis.

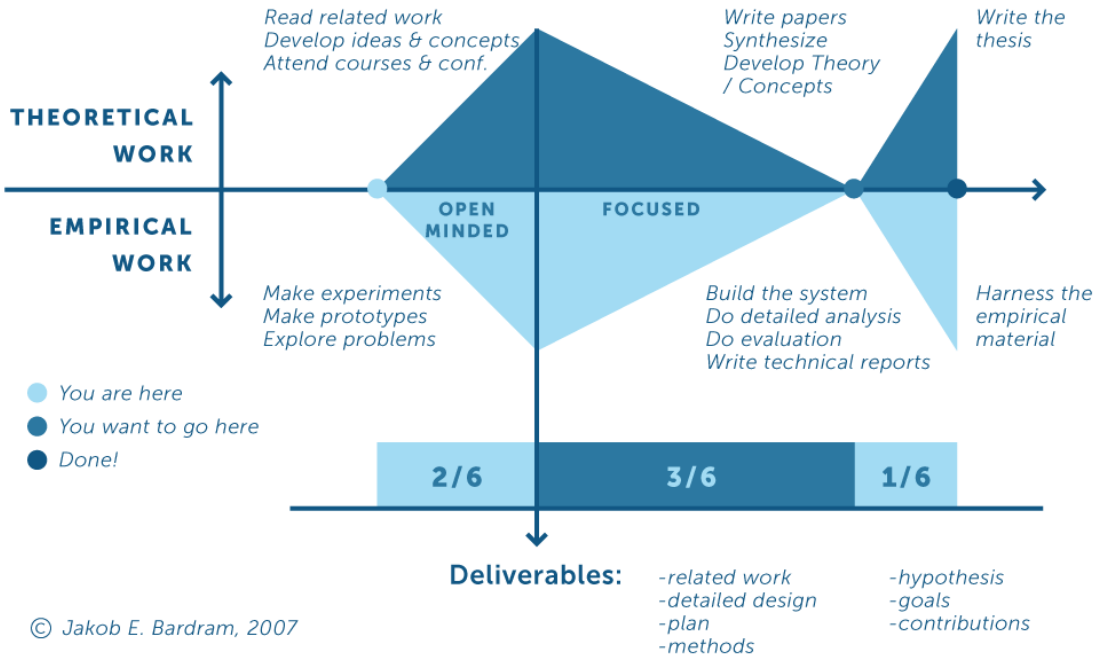


Figure 14: The Fish Model by Jakob E. Bardram

This model was useful to get an overview of the process of making a thesis, to easily map the tasks to be done in a timeline in order to make a plan (See 3.4.1 Gantt Chart).

However, despite the figure, the actual thesis was written along with the project, not only during the last 1/6 of the project. The first set of deliverables represents the Project

Definition Report (PDR) handed in 30 days after the start of the thesis, which included a more in detail description of the project, the intended learning objectives of the thesis, and the plan to be followed to complete the thesis.

3.2 Stakeholders Interviews

A user-centered design process requires involving the stakeholders in the process from the early stages in order to avoid deviation and create the most accurate solution for the users efficiently. To do so, the methods employed were the interviews and feedback sessions with representatives from the key stakeholder groups.

The interviews or feedback sessions in this project were carried along the entire process. They will be described in the following categories: student interviews, mental healthcare professionals interviews, and other feedback sessions.

3.2.1 Student Interviews

In order to get a better understanding of the issues that students are facing, and the interests they might have towards an app that could potentially help them solve those problems, a series of interviews with different students were set during the process.

These interviews were semi-structured and informal, as it was important to create an environment in which students could feel comfortable talking about the difficulties they might face during their studies.

During the first stages of the project, when deciding on the selection process of students to be interviewed, a question arose: is it ethical to ask the Student Council for students with mental health problems to be interviewed? And if so: Does the author own the necessary set of skills and knowledge to be able to interview a person with severe mental health problems?

After discussing with the supervisors about these questions, a new agreement was reached to pivot and interview students with mild mental health related problems as they were more commonly found issues and usually easier to speak about it, without the need for professional expertise or the fear of making a problem worse.

During the initial search for students to potentially be interviewed, it became clear that there were two important differentiating factors between national/european students and international students: while national and european students do not have to pay tuition fees and have access to SU, international students do not have access to SU or the free tuition fee. These differentiating factors clearly reflected on their worries and mental health issues (see 3.3.1 Persona).

The topics covered in the interviews varied along with the project. The initial interviews focused on understanding the problems from the student's point of view and brainstorming on possible solutions. These interviews helped set the direction and focus for the project.

Ahead in the project, the interviews focused entirely on the solution, asking the students to test and provide feedback on the initial prototypes in order to iterate based on all the stakeholders interviewed. These interviews were the first touchpoint between potential users and the early versions of the prototype, helping in the design of a more accurate solution.

The level of detail of these interviews was higher than the initial ones, thus following Jakob Nielsen's theory, where elaborate usability tests are a waste of resources and the best results come from testing no more than 5 users and running as many small tests as you can afford (J. Nielsen, 2000), only five students tested the app in each iteration.

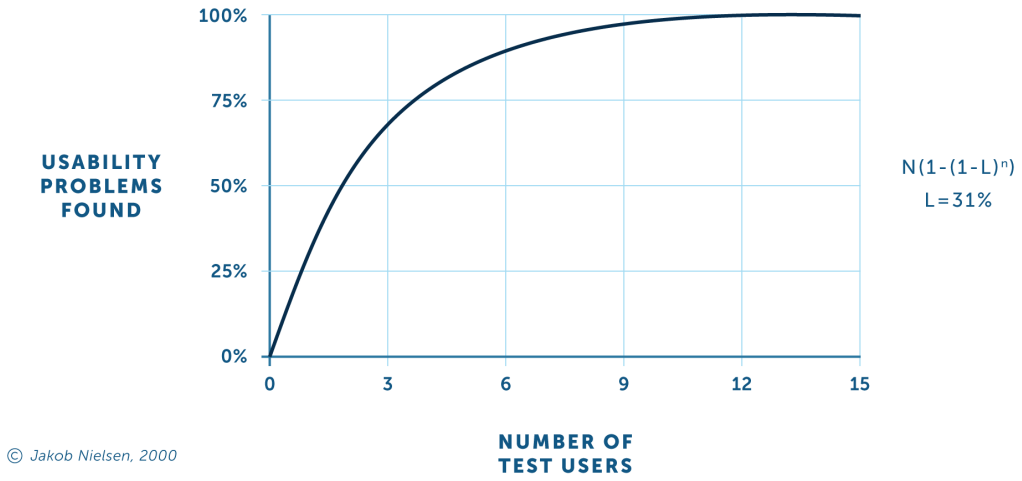


Figure 15: Number of usability problems found in a usability test with n users. Jakob Nielsen & Tom Landauer

In this theory, from the fifth test user onwards, the slope of the curve flattens, becoming horizontal and reaching 100% of usability problems with between 12 and 15 test users. However, this theory supports that the number of resources needed to test 15 users compared to 5 does not necessarily reflect the same rate in the usability problems found.

The concrete information on the conclusions based on the feedback from the interviews can be found in the iterations of the prototype (see 4. Prototype).

3.2.2 Mental Healthcare Professionals Interviews

Mental healthcare professionals played an important role in the design process, providing useful resources in the early stages and feedback during the prototyping process.

Two healthcare professionals were involved in the project, Dr. Miguel Álvarez de Mon (Alvarez-Mon MA) from the Hospital Universitario Infanta Leonor in Madrid, Spain; and Freja Petersen from the Studenterrådgivningen (Student Council) in Copenhagen, Denmark.

Studenterrådgivningen

SaludMadrid Hospital Universitario Infanta Leonor

Figure 16: Studenterrådgivningen and Hospital Universitario Infanta Leonor logos

The interviews with them were structured (see B. Appendix), but most of the time these interviews lead to semistructured or informal conversations where the interviewer asked questions that arose during the first part of the interview.

Similar to the students' interviews, the topic changed along the process, while the first interviews focused on understanding the situation and how the process works, once the overview was clear, the interviews focused more on the clinical aspects of the prototype.

Getting to know the student's problems from a professional point of view provided a more detailed picture of the situation. It became clear that from the clinical point of view you can distinguish two levels of conditions in students: the 'mild' problems that can be treated by the Student Council and the 'severe' problems that are transferred to a hospital. This distinction helped build the student's user journey (see 3.3.2 Scenario Related Tools).

The clinicians pointed out the most common issues faced by students, classifying them in two categories above, the 'mild' problems like stress, anxiety, panic attacks, fear of failure and worry, and the more 'severe' like depression, self-damage, and addictions.

According to the Student Council, there is a big gap between the students that are treated (5.000) and the students that are struggling with one or more issues (50.000). To tackle this, the Council focuses part of their resources on prevention, together with institutions they reach the high school students before they enter the university and ask them to fill in a questionnaire and assess their mental wellbeing by classifying their answers into levels of wellbeing and trigger mindset interventions. However, they are highly dependent on institutions to reach their students and it is not always an easy way.

From the moment a student contacts the Student Council, they arrange a first meeting to develop the profile of the student's situation in terms of studies, financial, mental, and practical. The meetings are scheduled every two weeks, three weeks, monthly, or even only once depending on the needs of the student.

There is also a questionnaire ruled in the first and last meeting to assess their progress (emotionally, relationship and overall) as part of the feedback informed treatment employed by the council, a method to monitor clinicians' performance that, based on research, when used on an ongoing basis patients are 2.5 times more likely to experience a benefit (D. Miller S., 2018).

About the digital solutions employed during the treatment of a patient, the Student Council pointed out the Mindistrict as a platform for the students' self-help, where they can complete modules on certain aspects, learn about different conditions, and even log entries in a diary.

3.2.3 Other Feedback Sessions

The environment at CACHET provided a variety of professionals and experts in some of the topics treated in the thesis. Apart from the supervisors' meetings, some other feedback sessions with developers and an ethics design expert were useful for the outcome of the project.

cachet Copenhagen Center for Health Technology

Figure 17: Copenhagen Center for Health Technology (CACHET) logo

The feedback session with Giovanna Vilaza, an expert in ethical design, provided very useful insights in transparency and ethics in the design of the app, in terms of giving the user the power of deciding what to see in the app, giving them all the information they

might want to see about their participation and data in the app, and giving the users the choice of erasing their account at any moment and delete or keep their anonymized data for the clinicians. This was implemented with a prototype of an informed consent flow and by updating the profile screen.

3.3 Design Tools

Part of the design tools employed during the project are classified below into two groups: tools focused on the user and tools focused on the scenario or environment surrounding the problem and solution. Together, both kinds of tools cover the whole solution space and provide useful information and insights to build a better solution.

3.3.1 User related tools

An interesting analysis of the difference between a user and a persona was stated during the UX Design and Prototyping course: A user is an abstraction of a person interested in your system, vs a persona that is often an imagined person representing a generalized class of users vs an actor that could be also others than the primary users or even other systems (Per Bækgaard, 2019).

The following tools employed during the design of the app focus mainly on the users, the students, providing insights and more detailed information about them and their relation with the app in order to create a better and more accurate design.

Personas

In order to have a clear view of the targeted users in a design process, a Persona is a useful tool. A Persona is a character-driven tool, fictionally created to personify the real users of the solution.

The following two personas are examples of users targeted during the design of the app.

Anne, danish, and Mohammed, international, cover the whole spectrum of nationalities of students in Denmark, with their different conditions and frustrations.

Anne, like other danish and european students, in general terms, lacks a huge economic pressure as they have free tuition fees and access to government aid like SU. These conditions reflect directly on their frustrations, more orientated to the fear of failure and leaving up to the expectations set by them and their environment. Other factors like living far from home, adapting to a new environment, or people, may result in some other conditions.

Mohammed, an international student from India, represents the students from outside the EU that are not able to get the same aid from the government as EU and danish students and have to pay the expenses of the tuition fee. Some of the students have to get in debt in order to afford to study in Denmark, which is undoubtedly a pain point for them that can lead to mental health issues. Thus, Mohammed is dealing with big cultural contrast in Denmark, not only in terms of the country, food, and climate, but also trying to make new friends is difficult for him, every course he takes he has different classmates, which makes it difficult to build relationships. He is a family guy, and living far from home without affording to visit his home or bringing his family here has been tough. Luckily he has found other students going through similar situations and they can support each other

and gather every once in a while.

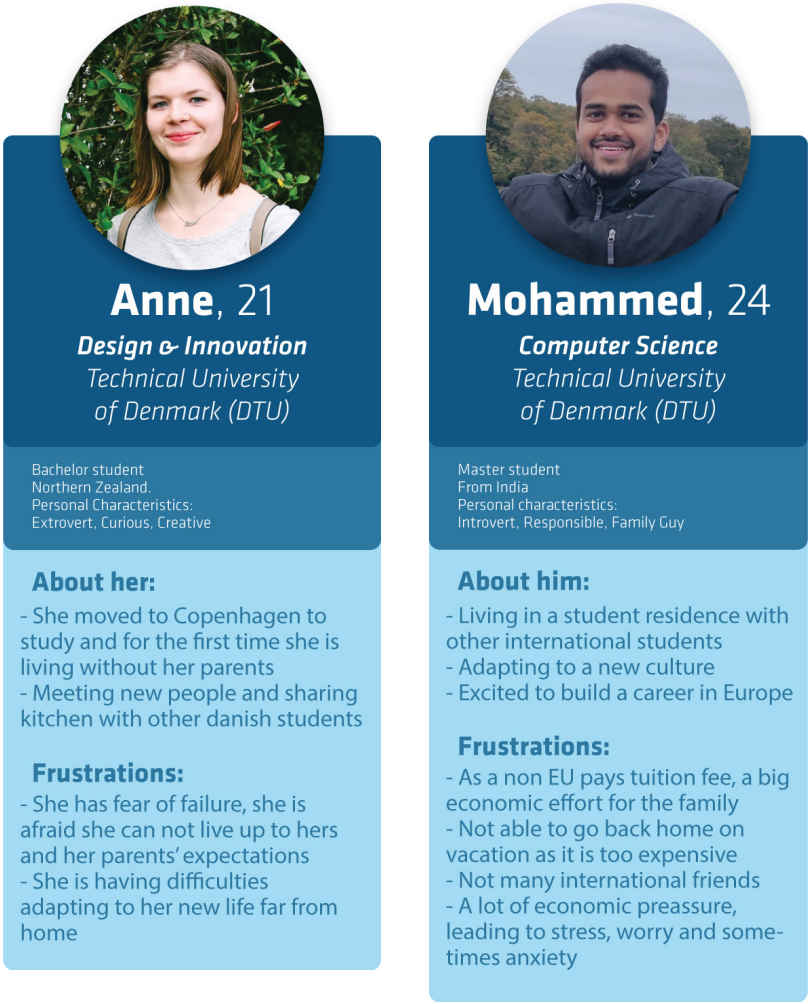


Figure 18: The two personas developed during the design process

Neither of both personas created is receiving any kind of treatment to improve their mental health, they represent the gap described before (see 1.1 Background), and they could benefit from a solution that represents an intermediate step between not doing anything for their mental health and going to a psychology session or similar. In this sense, an app that helps students assess their mental health would be welcomed by them.

User Story Map

User stories are short, simple descriptions of a feature told from the perspective of the person who desires the new capability, usually a user or customer of the system (Cohn, M, 2009). In this method, the *goals* represent something the users want, and to achieve them, they will need to complete some *activities*, divided into smaller and more detailed *tasks*.

The user story map was updated through the process as the feedback provided by the stakeholders continued to change the activities. The final version is depicted in the figure.

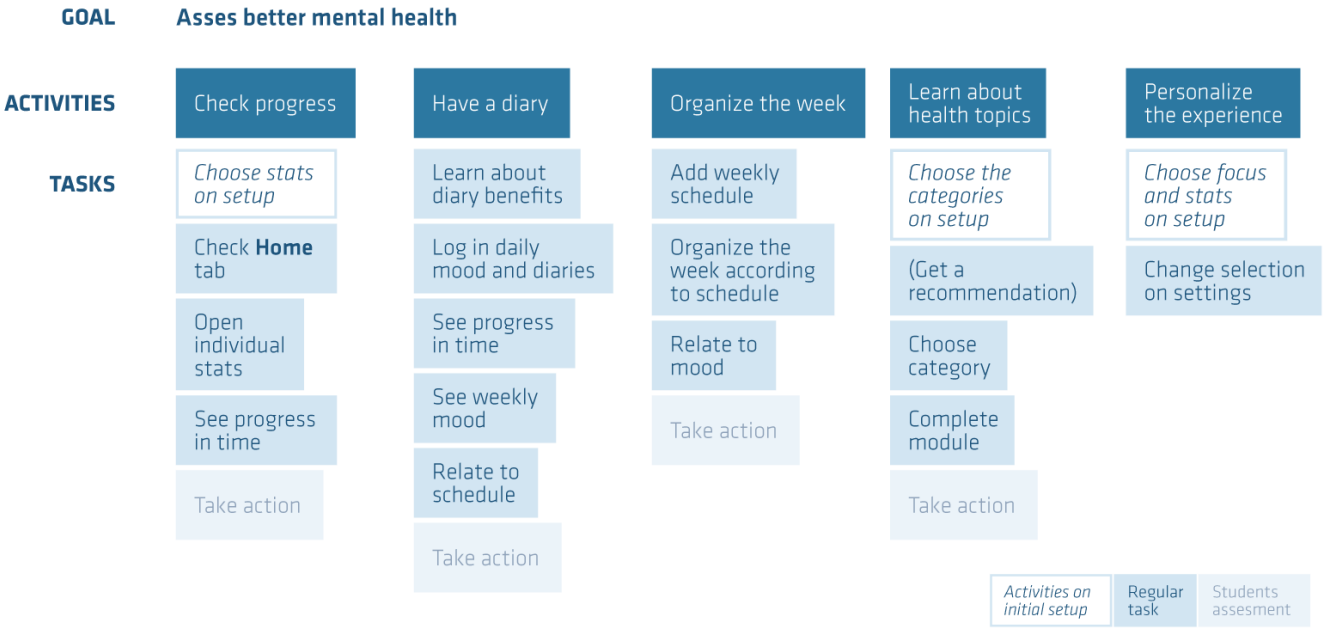


Figure 19: User story map

The user story map of a student using the app can be summarized in five main activities: check progress, have a diary, organize the week, learn about health topics and personalize the experience with the app. Each of them is divided into individual tasks. At the end of some of the actions, the student is supposed to reflect on the activity and do something to improve their wellbeing. For example, when completing *Organize the week*, the user must reflect on what activities are making him score low in mood and try to change them. Another example would be at the end of *Learn about health topics*, where the user must reflect and apply if possible the learnings to his wellbeing.

Some of the tasks inside the activities are meant to be completed only once, regardless of the number of times the activity is completed, this is due to being part of the initial setup, where the user is asked to make a series of choices. These choices can later be changed in the *Personalize the experience* activity.

3.3.2 Scenario Related Tools

The second kind of tools employed during the process focus on the scenario where the solution is to be developed: the space for the solution and the relation with the users.

In order for a solution to be useful, it needs to fit into a certain environment. To explore this environment and build the scenarios where the app will sustain, two of the tools used were the stakeholder map and the user journey map.

Stakeholder map

The stakeholder map gathers the key actors involved in the product into the same picture, depicting the relation and the role they play in the map. There are four main stakeholders in this map: students, clinicians, the university, and the app (CACHET).

Students are the central character of the map, they are the users of the app and their goal

is to assess their mental health in order to improve it. They may or may not have a relation with the clinicians, depending on their wellbeing and needs.

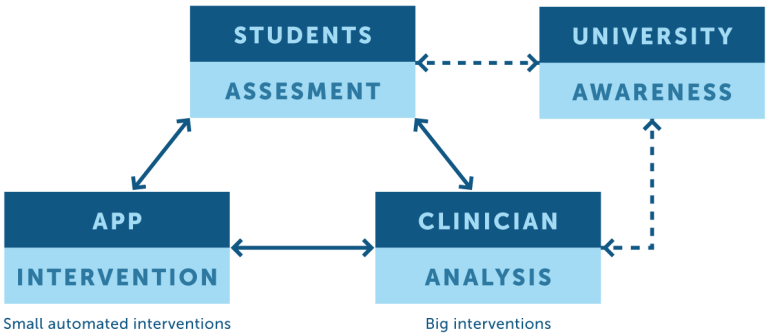


Figure 20: The stakeholder map

The university provides a link between clinicians and students, as explained by Freja in the interview with the student council, they do not have a way to reach students in the first place other than by each university. This leaves the university responsible for raising awareness and prevention.

Clinicians, part of the Student Council or some other mental health institution, are the only responsible for big interventions and severe cases, these cases can be identified by the data they get from the student using the app or directly by the student. This is one of the cases where they do have direct contact with students as they can be considered patients.

The remaining stakeholder in this map is the app, directly linked with students and clinicians, provides small automated interventions based on sensing and questionnaires and triggers, if needed, alerts to clinicians.

The central triangle of the map represents the eHealth cycle often used in CACHET's projects to depict the relationship between patients, the healthcare center, and the app/ CACHET.

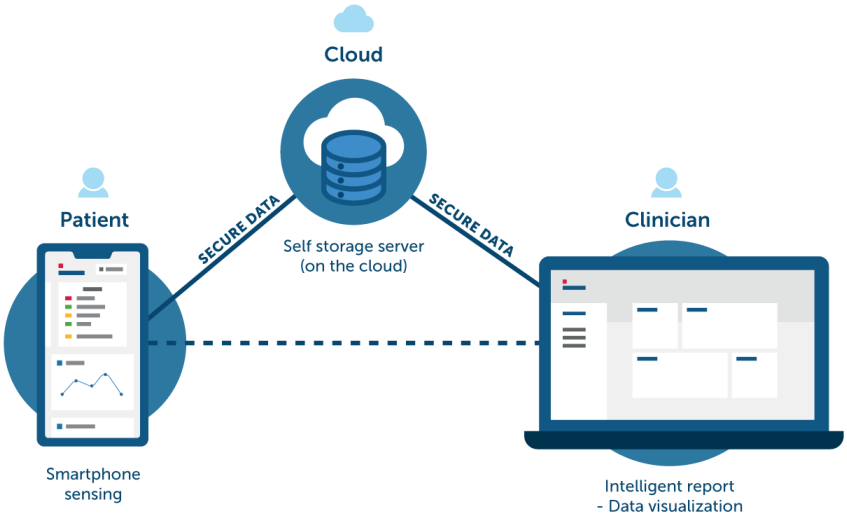


Figure 21: eHealth cycle at CACHET

User Journey Map

Other tools applied before like the user story, which is a short description of what users want to achieve and do with your system, and use case, that details the concrete interactions, do not provide a bigger picture. The user journey looks at the entire flow and experiences through possibly multiple user stories (Per Bækgaard, 2019).

Similar to the other tools described, the user journey map was updated during the process. After meeting with the healthcare professionals, in order to get a better understanding of the process of a student looking for help, following the information given by the clinicians a user journey was created.

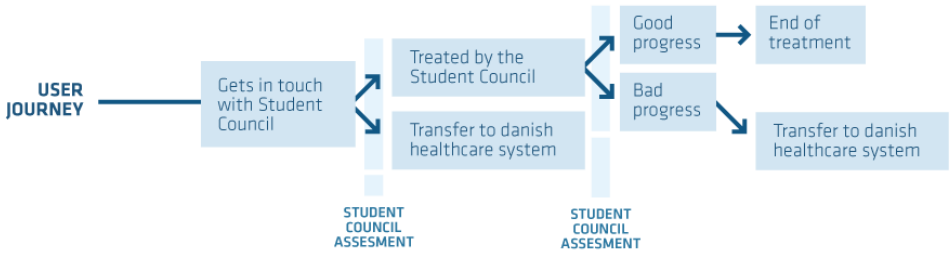


Figure 22: User journey map without the app

In this first user journey, the student gets to know the Student Council by the awareness risen by the university and gets in touch with them to assess his or her mental wellbeing and situation. After this first assessment is made, the Student Council decides if the patient needs to be treated by the Danish Healthcare system or he/she can be treated by the Student Council. If the Council decides to continue the treatment with the student, they will arrange either physical meetings, workshops or zoom meetings with the student in the frequency they estimate is best until the end of the treatment. However, if the student gets worse, he or she will be transferred to the Danish Healthcare system.

The last user journey pretends to alleviate the clogging of students treated by the Student Council by adding an intermediate step between the student not doing anything and the student reaching the Student Council.

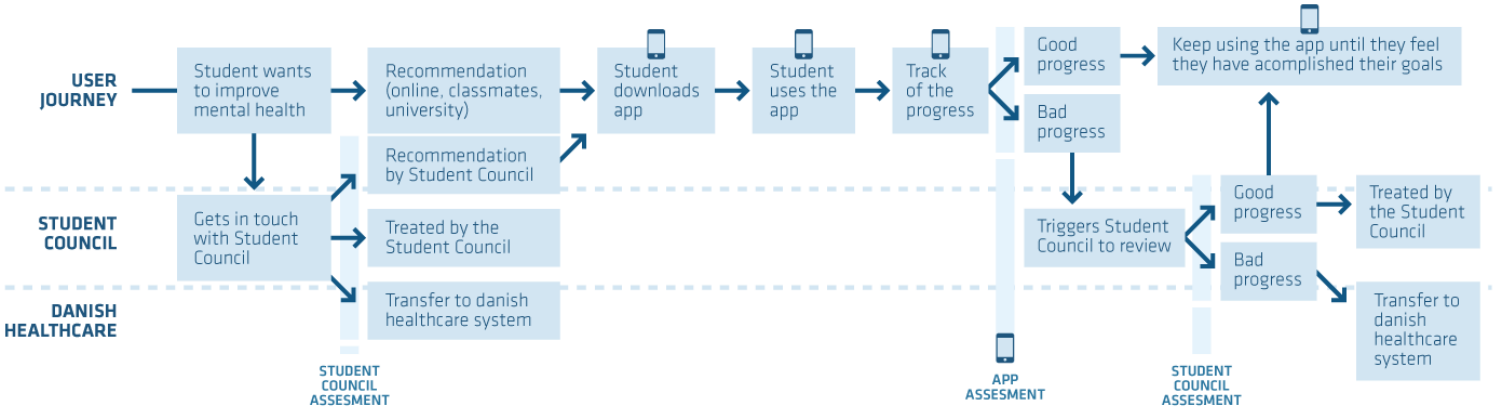


Figure 23: User journey map with the app

In this new user journey, the student, motivated by their desire to improve their mental health or wellbeing in general, and recommended by other students, the university, or the Student Council, downloads the app. In the case where the student contacts first the Student Council, after an initial assessment, the Council decides the treatment to follow with the student: transferred to the Danish Healthcare system, treated by them following the first user journey, or treated with the app.

Once the student has downloaded the app, he or she will follow the user story map (see 3.2.1 User Related Tools) while the app tracks the process, at any point in this journey, the student can decide to contact the Student Council if he or she feels like the app is not enough help. The app will keep track of the process and trigger small interventions to help the students assess their mental health. However, very poor results in questionnaires or alarming sensing can trigger a notification to the Student Council to act. For example, if a student, filling a questionnaire, answers below a certain score in the CAGE questionnaire for alcohol abuse, it can trigger an alarm in order for the Student Council to contact the student.

After a trigger activation, the Student Council has to manually review the case and assess the procedure to follow with the student, either refer back again to the app, continue with a traditional treatment or transfer to the Danish Healthcare system for further treatment.

3.4 Plan

For the first deliverable, the Project Definition Report (PDR), a plan was established. This plan involved a Gantt chart, the activities to be completed, the milestones to be reached, the deliverables to hand in at the end of the project, and a risk analysis.

3.4.1 Gantt Chart

Figure 24 shows the outline of the Master's Thesis project.

As stated in 3.1 Design Methodology, this project involved the stakeholders from the start of the project. It was crucial to get a good understanding of the problem and the environment surrounding it, to do so, six weeks were employed analyzing the problem domain by studying the related literature and carrying user studies and interviews that continued throughout the project. At the end of this phase, a clear problem definition was stated.

During the same period of time, the author worked on the PDR, as during the first month it must be submitted as the first deliverable. Certain chapters written in the PDR settled the grounds for other chapters of the actual thesis. In order to document the finding of the analysis of the problem domain, chapters like the introduction and the related work were planned to be written during the initial phase.

Once the problem definition was clear, the design phase began. This phase of the plan was divided into an initial ideation and prototyping phase, and two iterations of the prototype, each of them supported by feedback and testing. The result at the end of this phase is a final app design.

The last step of the plan consisted in documenting and writing these last processes in the thesis. This last step ends with the thesis hand-in and the end of the thesis.

Analysis of problem domain	
STUDYING RELATED LITERATURE	6 WEEKS
USER STUDIES & INTERVIEWS	6 WEEKS
PROBLEM DEFINITION	
Design and test of Prototype	
IDEATION	2 WEEKS
PROTOTYPE DESIGN AND TEST	4 WEEKS
1ST ITERATION AND TEST	4 WEEKS
2ND ITERATION	2 WEEKS
APP DESIGN	
Project Definition	
PDR	4 WEEKS
PDR APPROVED	
Thesis	
INTRODUCTION	1 WEEK
RELATED WORK	1 WEEK
REQUIREMENT SPECIFICATION	2 WEEKS
OTHER CHAPTERS	5 WEEKS
RESULTS	1 WEEK
WRITING UP FINAL THESIS	2 WEEKS
PROOF READING	1 WEEK
THESIS HAND-IN	

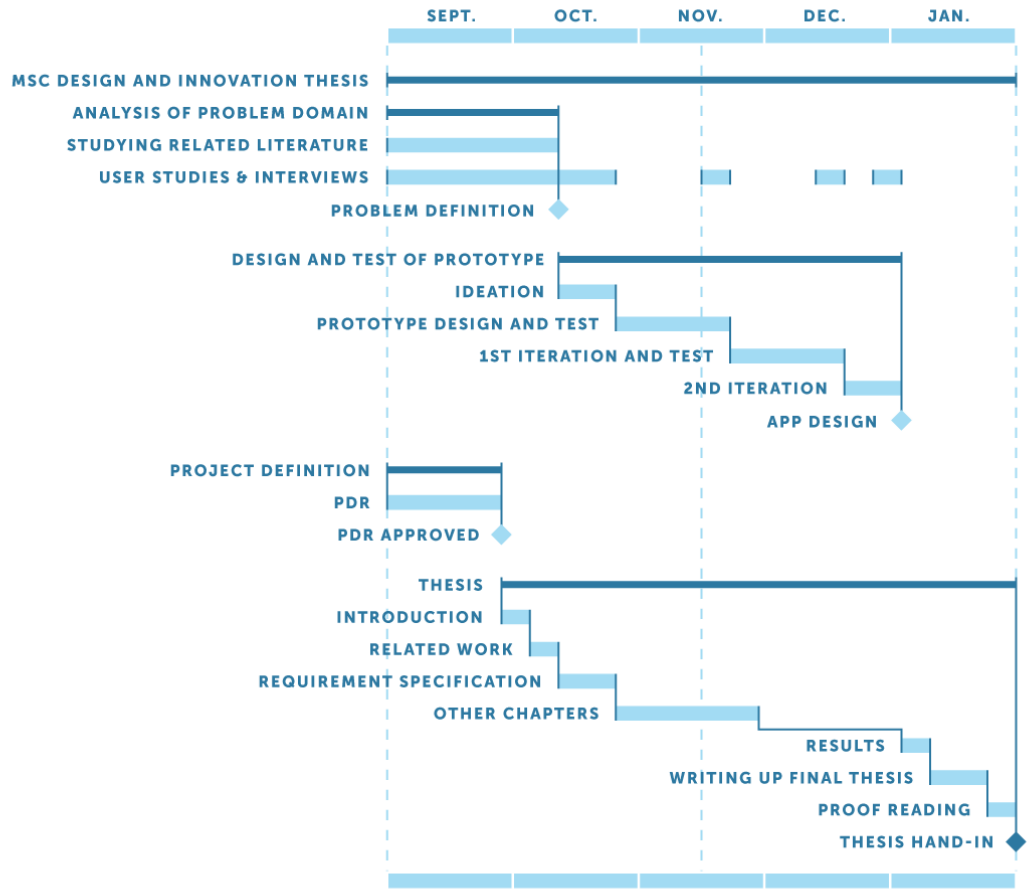


Figure 24: The Gantt char for this MSc. Thesis project

3.4.2 Activities

The main activities and phases of the plan are the following:

#	TITLE	DESCRIPTION	PHASE	PERIOD
1	Analysis of Problem Domain	Researching and interviewing the stakeholders of the project.	Analysis of Problem Domain	W1–W6
2	Project Definition	Writing up the PDR and planning the whole project.	Project Definition	W1–W4
3	Writing up Thesis	This is the final writing up, including all the chapters.	Thesis	W4–End
4	Design and Test of prototype	Ideating the solution and testing the different prototypes with the stakeholders.	Design and Test	W6–W18

Table 1: Project phases and activities

3.4.3 Milestones

The main milestones of the plan are described in the table below:

#	TITLE	DESCRIPTION	TYPE	WEEK
M_1	Project Definition Report	Hand-in of PDR.	TH	4
M_2	Problem Definition	Scope the project	D	5
M_3	Prototype 1	Designed the mock-up of prototype 1	D	10
M_4	Prototype 2	Designed the mock-up of prototype 2	D	14
M_5	Final app design	Designed final the mock-up	D	18
M_6	Thesis hand-in	Hand-in of final Thesis	TH	T

Table 2: Milestones. D:Deadline, TH:Thesis

3.4.4 Deliverables

This section provides a table of the main deliverables included in the final thesis:

#	TITLE	DESCRIPTION	TYPE	WEEK
D_1	Project Definition Report	Final version of the PDR.	R	4
D_2	App design	The main deliverable inside the thesis, a mock-up design of the app	SW	18
D_3	Final Thesis	Designed the mock-up of prototype 1	R	T

Table 3: Deliverables. R:Report, SW:Software

3.4.5 Risk Analysis

The table below includes a risk analysis of the three biggest risks that could upset the project:

#	TITLE	DESCRIPTION	RISK	WEEK
R_1	*Recruiting students for the tests*	*Enrolling enough participants to test the prototypes*	*2*	*8–16*
R_2	*Recruiting students for the interviews*	*Enrolling enough participants to interview them about the topic*	*3*	*0–11*
R_3	*Recruiting clinicians for the interviews*	*Enrolling enough clinicians to interview them about the topic*	*3*	*0–11*

Table 4: Risks. 1:low risk, 5:high risk of delays

4. Prototype

During this chapter, the prototyping process will be described. Starting from the requirements definition, followed by the first prototype design and the first test, the second prototype design, based on the feedback obtained in the first test and the posterior test, and the final prototype with the final test. Then, examples of the logic behind some of the interventions will be described. And finally, a brief description and examples of the use of smartphone sensing by the app.

4.1 Requirements

Starting from the problem statement: design an app to help students improve their mental health; together with the literature read, the previous work and the user needs to be extracted from the interviews with stakeholders, a set of requirements was defined.

The initial set of interviews with the mental healthcare professionals pointed out the difference between self-administered healthcare, the one administered by the patient without the help of a third party, and hetero-administered healthcare, administered by a clinician on behalf of a patient. The focus was set on self-administered health care, aiming to provide tools for the students to assess better their mental health.

There is a wide variety of mental health issues that students face. In order to decide where to focus the solution design, the mental healthcare professionals were asked to identify the most common issues that students can tackle by themselves os together with the Student Council. They identified the five most common problems: stress, anxiety, panic attacks, fear of failure, and worry.

Out of these initial interviews, the mental healthcare professionals described some of the tools they use with patients or they encourage patients to use in order to tackle these problems. Both of the clinicians agreed on how it is beneficial for the patients to have a diary where they can reflect on their day, and how these diaries are afterward useful in the appointments with patients to get an overview of their wellbeing since the last appointment. Patients often, when asked about how they have been feeling for a long period tend to be biased by their latest feelings.

Another solution employed by the Student Council in the treatment of students with the abovementioned problems is provided by the online platform Minddistrict, which offers the patient modules focused on topics they might be struggling with (i.e.: sleep, exam anxiety, etc). These modules combine information about these topics with useful exercises and practices for the students to apply in their lives.

About the mental health problems suffered by students, in order to decide where to set the focus in, during the initial interviews, clinicians were asked about the treatments they would follow with patients suffering from each of these conditions if they had to treat them telematically. After analyzing the different treatments it became clear that the five most common conditions shared the same structure in terms of treatment, only differing in the questionnaires to be sent and the modules to be recommended. This pushed the design focus into the abovementioned five most common issues.

Miguel A. de Mon, doctor, and Jakob Bardram, supervisor at CACHET, both insisted during this early stage that the app should be designed to reduce the dropout rates. This is an

increasingly recognized challenge for health research, as low engagement and dropout hinder interpreting and translating the findings from health-related apps (J. Torous, 2019). To earn engagement with the students, they have to get something in return from the app, they have to feel involved in order to be motivated. Students were interviewed about this matter, and the main takeaway from their answers is that they want to see progress, improving in terms of wellbeing does not seem to engage enough, they wanted to be able to check their statistics and measure the improvements. When looking into research about engagement, a study pointed out that the ease of use is closely related to the intent of use, and in some ways actual use (M. Haan, 2019), therefore, simplicity and easiness should be a requirement in order to engage students.

Students' interviews, in the early stages, focused on the overall solution. They were questioned about the methods they use to tackle by themselves the mental health issues they face during their studies. The range of answers oscillated between social interaction with friends or family, relaxing methods, sports, and, interestingly, organizing themselves. During the ideation process, it was studied how to include features in the app to help them deal with the issues as they are used to doing it.

During this initial stage, clinicians highlighted the risks of having big automated interventions in the app. Instead, it was suggested that the app, by setting triggers (see 4.5 Triggers), could take care of small automated interventions that do not suppose a big risk for the patient wellbeing, and healthcare professionals will remain in charge of the big interventions.

It was also during the ideation stage where the decision of whether or not to design a platform for the mental healthcare professionals to visualize the results of the students' app was taken. However, together with the supervisors, it was considered to be out of the scope of this thesis.

In the first interviews, clinicians pointed out the importance of following standardized guidelines for the evaluation of mental health apps, thus, highlighting the American Psychiatry Association App Evaluation Model as the most recognized by healthcare professionals. This evaluation model focuses on the background and accessibility of the app, privacy and security, clinical foundation, usability, and data integration towards a therapeutic goal (APA, 2021). During the entire design process, these topics were taken constantly into consideration.

The clinical guidelines closely followed were extracted from Dr. Miguel A. de Mon's Telecare Course (Alvarez Mon MA, 2021), where the doctor describes some recommendations for the design of mental healthcare applications based on the APA guidelines. The recommendations are the following:

- Be Cognitive Behavioral Therapy (CBT) based, effective for a wide range of problems including depression, anxiety disorders, alcohol and drug use problems, and eating disorders.
- Address both anxiety and low mood.
- Design to be used by nonclinical populations. In this concrete case, design for students.
- Recommend activities as a way of intervention.

- Provide mental health information to the users.
- Include real-time engagement features.
- Include activities explicitly linked to specific reported mood problems.
- Encourage nontechnology-based activities in the interventions.
- Include features that provide intrinsic motivation to engage.
- Set reminders for users to engage, as another way to lower the dropout rate.
- Use simple and intuitive interface and interactions. Avoid cumbersome designs.
- Provide links in-app to crisis support services.
- Tun experimental trials to establish efficacy.

In terms of design, the guidelines to be applied will be the Eight Golden Design Rules of Interface Design (B. Schneiderman, 2016). This set of rules was introduced to the author during the User Experience Design Prototyping course. These rules encompass the characteristics of a good design:

1. Strive for consistency; using identical terminology, consistent color, layout, and fonts.
2. Seek universal usability; designing for new and experienced users, providing explanations for novices and shortcuts for experts.
3. Offer informative feedback to the user actions.
4. Design with closure, turning activities into sequences.
5. Design to prevent human errors.
6. Allow undo, as much as possible, to relieve user anxiety.
7. Keep the user in control of the design.
8. Reduce memory load, users should only remember from one screen to the next one, providing them with the needed information on display.

Summarized, from the problem statement, the stakeholder interviews, and the research in previous work and literature, the requirements set for the design of an app to help students improve their mental health are the following:

- Focus on the five most common mental health challenges faced by the students: stress, worry, anxiety, panic attacks, and fear of failure.
- Combine and improve the existing online solutions used by the clinician such as the diary and the modules.
- Design to lower the dropout rates in health-related apps by including features of interest for the students like statistics and progress graphics.
- Include solutions proven to be useful for the students to manage their mental health like a feature to encourage them to organize their days.

• Design a library of small automated interventions based on the data extracted from the app and their responses to questionnaires and leave the big interventions to mental healthcare professionals.

• Follow closely the clinical guidelines stated by Dr. Miguel A. de Mon in his Telecare course: *On the way to the future of Care. Technical resources for teleconsultation*.

• Follow the American Psychiatry Association App Evaluation Model in the decision-making during the design process.

• During the design phases, follow the Eight Golden Design Rules of Interface Design by Schneiderman.

4.2 Initial Design

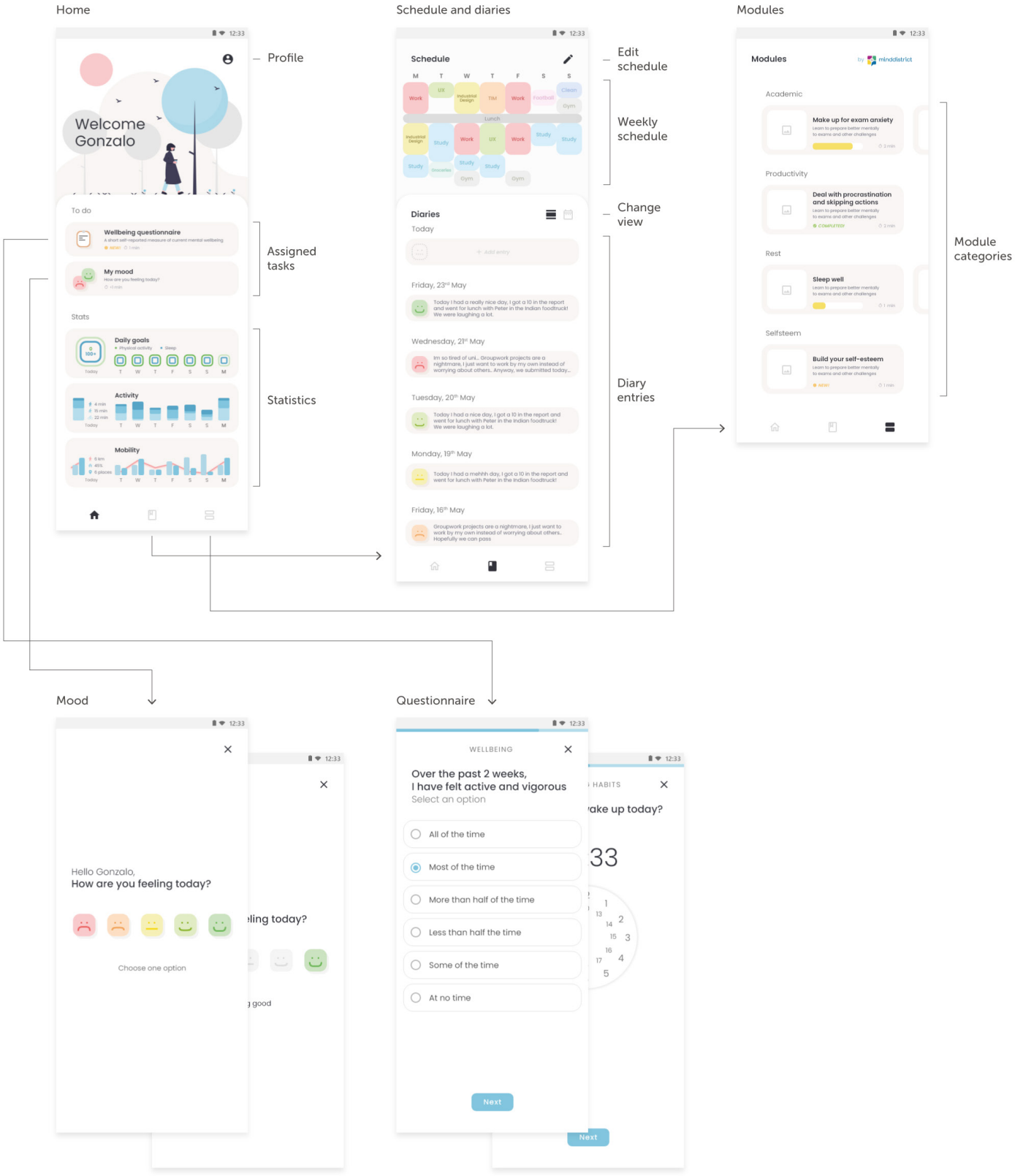


Figure 25: Prototype 1 wireframes

In this initial prototype, the app is divided into three tabs: home, schedule/diaries, and modules.

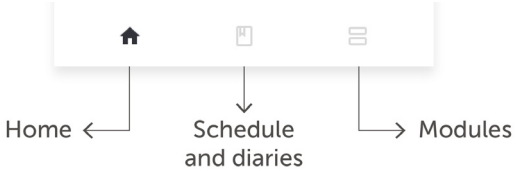


Figure 26: Bottom tab

The tab students get when they open the app is the Home tab, where they will get a welcoming message, the assigned tasks (questionnaires and mood), and the weekly statistics. To complete the assigned tasks, they click on the desired task and the questionnaire will open on top of the screen. When the task is completed, it will disappear from the home screen. Examples of the design of the mood questionnaire and wellbeing questionnaire are also provided. They are also able to scroll down to see more statistics. Finally, they have a profile button on the top right corner with account and app settings.

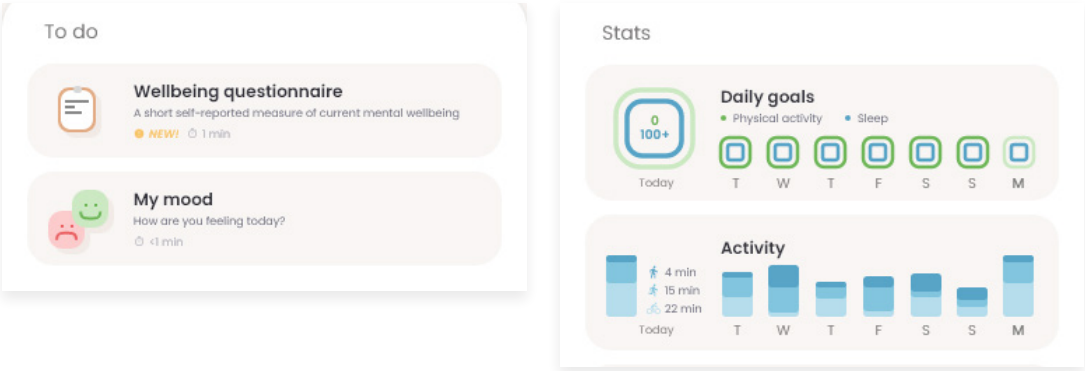


Figure 27: Assigned tasks and statistics

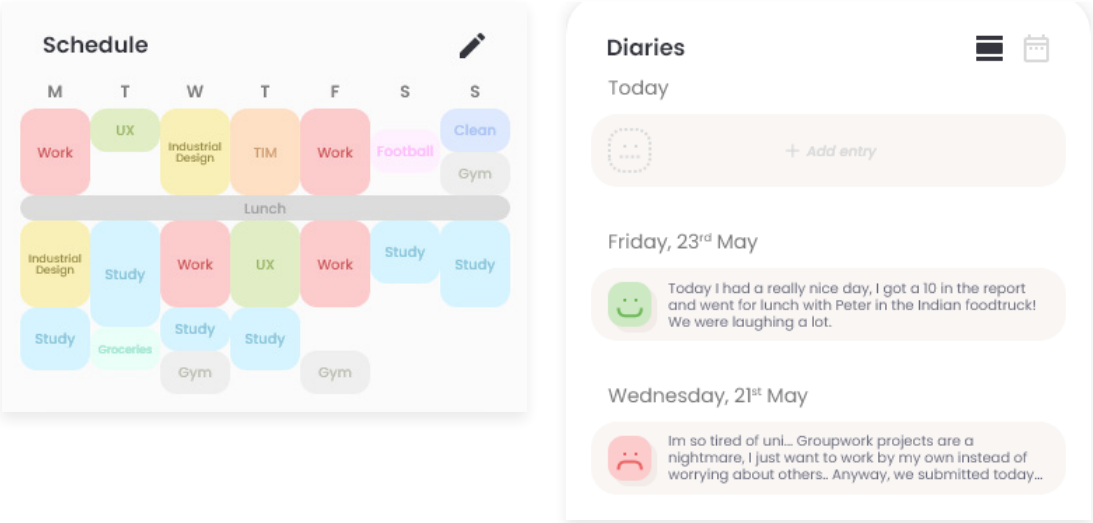


Figure 28: Schedule and diaries

The middle button in the bottom menu leads to the Schedule and Diaries tab. In this tab, the user can create and edit a weekly schedule to organize his/her week. Apart from that, this tab contains also the Diaries feature, where the user can fill in the mood and a description of the day. This is displayed in a timeline view, but it can be changed to a monthly view to have a wider overview.

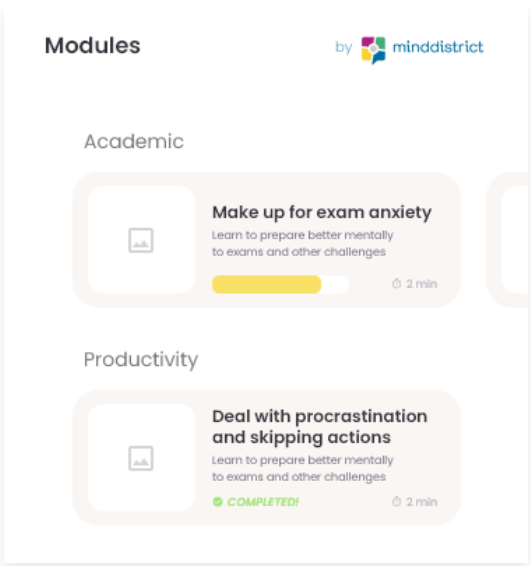


Figure 29: Modules

The last tab is the Modules tab. This tab will provide the users with exercises and information in modules format. These modules will be provided by Minddistrict, an online solution already employed by the Student Council. To complete them, the users will have to scroll and find the desired module and click on it.

4.2.1 First Test

The first test involving the prototype and the student was more generalist, meant to validate and set the direction of the prototyping process. The tests were carried out both physically and online with students, clinicians, and CACHET employees. They were asked to explore the working prototype in Adobe XD and then answer questions about it in the form of a semistructured interview, that often led to an informal discussion. Some of the questions asked during this test were:

- Would you describe this app as an intuitive app?
- Do you feel this app is encouraging to use?
- Do you think this app would be useful / help students with their mental health?
- Do you miss any features? Would you include something else in the app?
- Do you see something wrong? Would you change anything?

The response to the test was positive in general terms, encouraging to continue in the direction set. However, the testers provided useful feedback about aspects to improve the prototype.

Clinicians suggested finding a way to relate between the mood and the schedule: *"As you're asking the student about their mood, it would be nice if there was a graph of their responses, or if that could somehow overlay the schedule. That might help them pinpoint how their mood is affected by their activities."*

Clinicians also insisted on using gamification to increase engagement: *"I would also think about how to "reward" students for using it. Like, how to make them feel like they achieved something, or to give them something enjoyable – the gamification aspect is important with apps."*

Lastly, clinicians encouraged to include some sort of feature that would make the app stand out for students to use it above the others: *"I would think about how to make this stand out from other wellbeing apps – what should make a student use this one, over all of the others... Would it link in with their place of study, connect them to their peers, help them with study tips depending on the state of their wellbeing...?"*

The student feedback was equally useful, they pointed out aspects like the relation between the mood questionnaire and the diaries not being clear enough: *"Is there a relationship between the mood questionnaire and the diaries? If so, it would be interesting to integrate the 'Add comment' field also in the questionnaire."*

They also suggested including patterns detection or triggers and provided some examples: "*It would be nice if the app could detect certain patterns and comment on them. For example, 'Hey, you are very happy since you are exercising regularly', or 'Exam period is approaching, why don't you try to complete this module about exam anxiety*". Including these kinds of small interventions was planned in the requirements specification, initially, these interventions were meant to be brainstormed and designed by clinicians, however, the feedback provided by these students proved to be so helpful that they were included during the brainstorming process.

Another student, more concerned about anxiety, suggested including heart-rate and breath-rate sensing to measure anxiety levels. Another student, more concerned about healthy lifestyles, suggested including diet and other healthy habits in the modules.

The feedback received from Giovanna Vilaza, the professional at CACHET expert in design ethics was also useful. She suggested, as some students pointed out as well, that users should decide on what to see in the app: "*It would be interesting to provide a tailor-made experience for each user, not all of them will be interested in the same parts of the app or have similar objectives, they should be given choices. However, they should be able to change whatever they choose to focus on at any point during the use of the app.*"

She insisted on the importance of informing the users about the app, this point of view is shared with the APA: *"Users should be informed clearly about the app and be asked to give their consent to the terms and conditions of the app. They should be able to access this information at any point, and they should also be able to erase their participation and data whenever they want."*

She also suggested small changes to make the app more user-friendly: in the words used in the app change 'To do' for 'Today' and 'Stats' for 'Progress', and change the color selection in some features of the app.

4.3 Iteration. Second prototype

During the first iteration, the feedback received in the first test was translated into the prototype.

The first change was inspired by Giovanna's feedback, when the user opens the app for the first time, where she/he will navigate through an informed consent and a questionnaire about their focus. The informed consent was designed following Giovanna's feedback, the Privacy code of conduct on mobile health apps by the European Commission (EC, 2021), and the guide for Writing a GDPR-compliant privacy notice by the European Union (EU, 2021). However, designing the content of an informed consent involves such a workload that was considered to be out of the scope of the thesis. Therefore, this prototype will just provide a design of the wireframes' outlines.

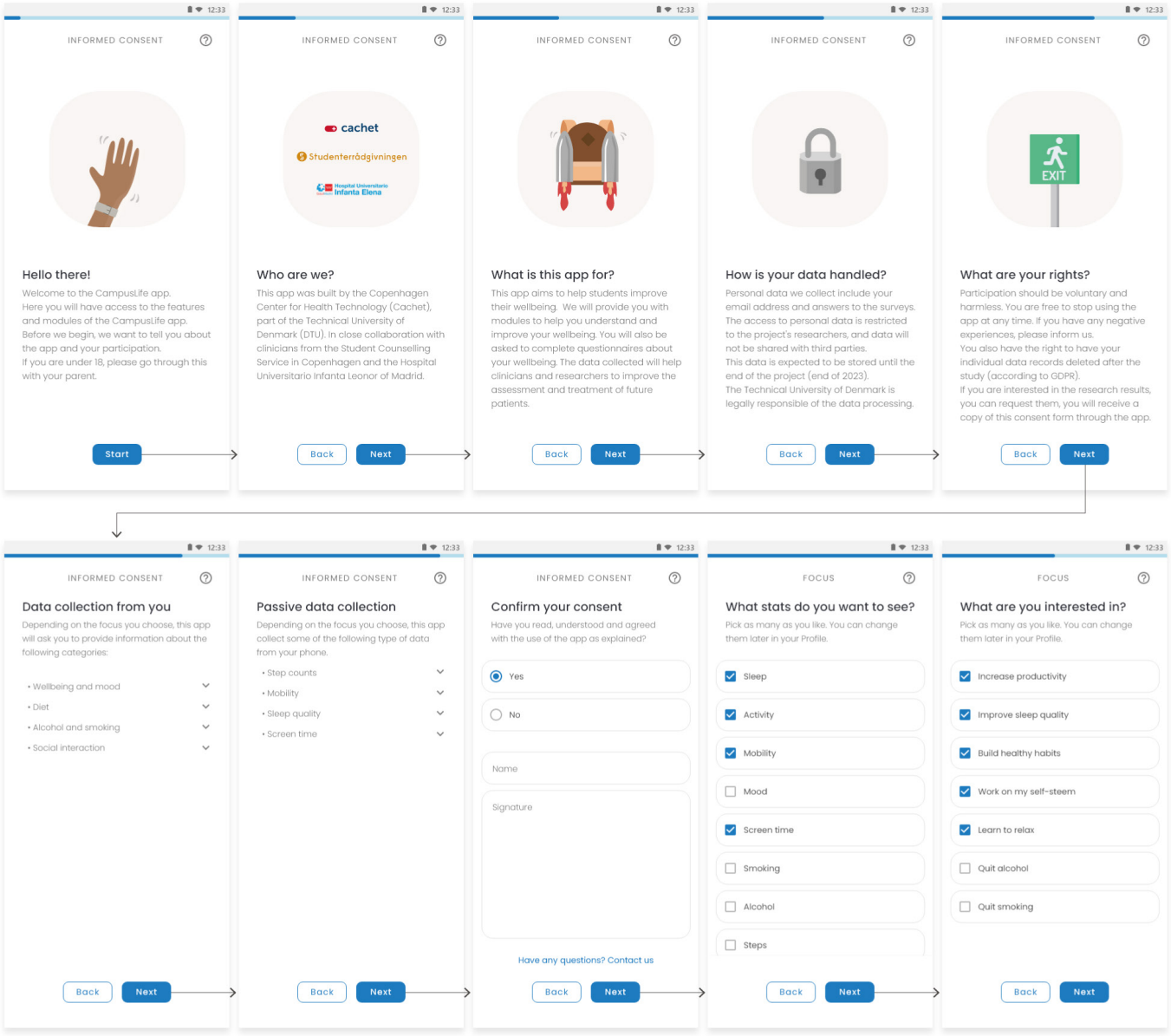


Figure 30: Informed consent and initial questionnaires.

Once completed and agreed to the informed consent, the users will receive a questionnaire about their focus in the app, selecting the topics they are interested in and the statistics they want to receive. These choices will determine the modules and statistics they will be able to see. If the user changes his/her mind, he can undo this decision on the profile page. The topics available to focus on were determined together with the clinicians. There is also a wide range of statistics collected from phone sensing available for students to choose what to see.

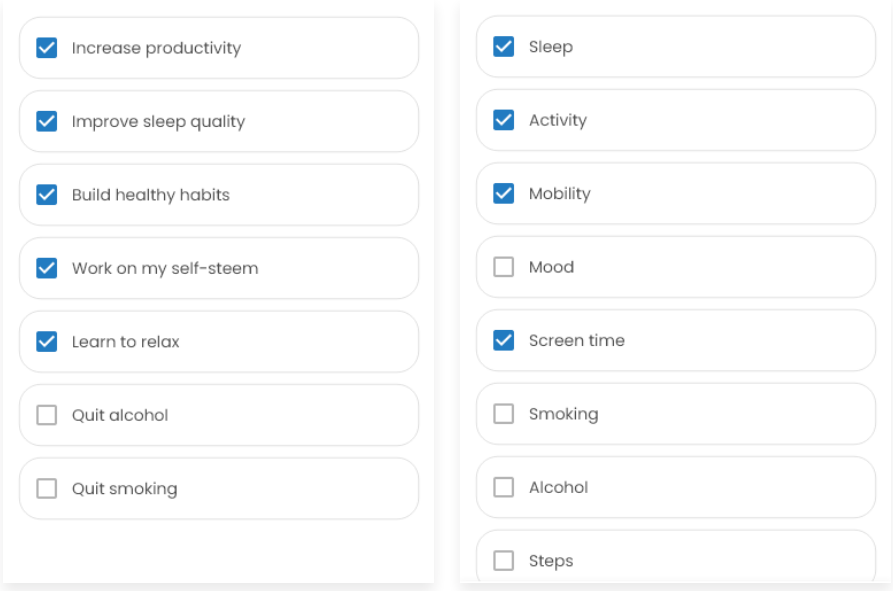


Figure 31: Initial questionnaires. Focus and statistics.

In the initial setup, an interrogation icon was added on the top right. This icon opens a screen to contact the app with any questions. See figure 34.

In order to make it more hassle-free, based on the students' feedback, the 'Describe your day' was integrated into the mood questionnaire. Therefore, users will be able to complete their diary in one step from the questionnaire instead of two. They will also get the same screen when they access from the Diaries page. See figure 33.

Clinicians suggested finding a way to relate the mood and the schedule to help them pinpoint how their mood is affected by their activities. This was implemented overlying the mood responses over the schedule.

Figure 32: Schedule and mood.

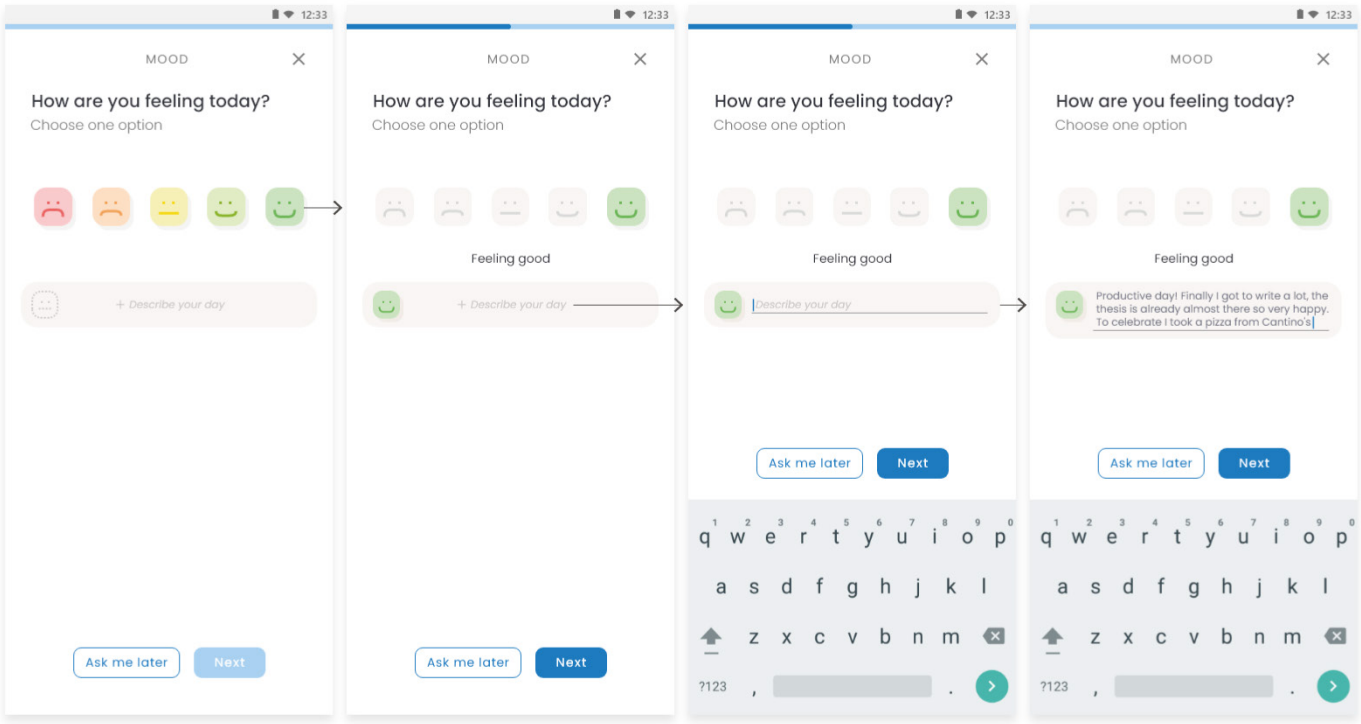


Figure 33: Initial questionnaires. Focus and statistics.

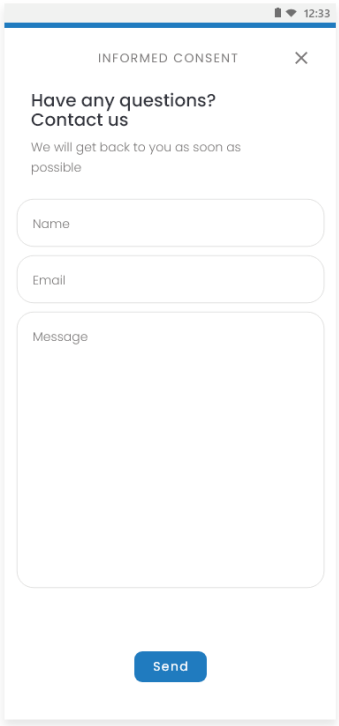


Figure 34: Contact us page.

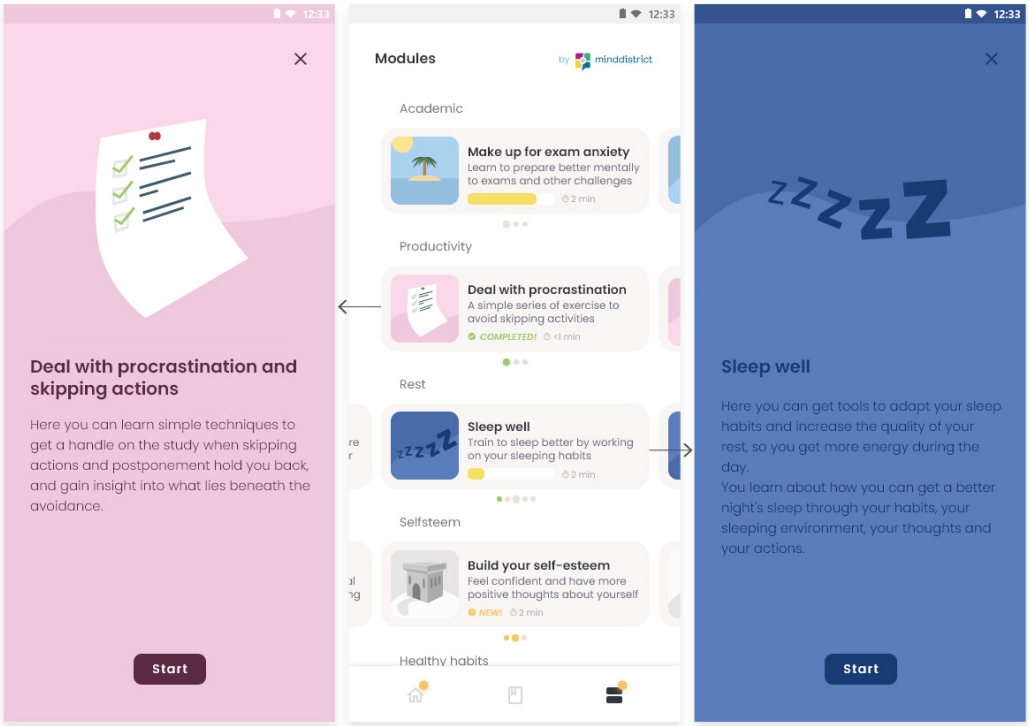


Figure 35: Modules page and starting screens..

As a way to include gamification in order to increase engagement, the streak was added in the home tab and the newly designed statistics individual screens. These statistics individual screens include more in-depth data, the user can browse through their weekly and daily statistics and see the suggested modules related to the topic. See figure 36 for the example of the sleep statistics.

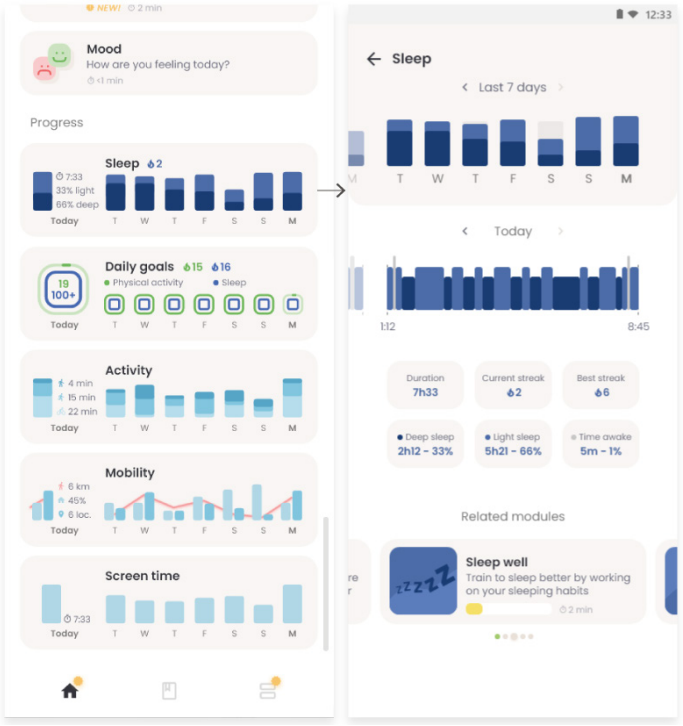


Figure 36: Statistics overview and detail view.

Based on the feedback given by students, more stats and modules were added to the home and modules screens. An intermediate screen between the modules tab and the modules was added, this screen describes more in-depth the module selected and provides a start button. See figure 35.

Lastly, the font size was increased in some of the screens based on the student's feedback.

4.3.1 Second Test

The second test was more specific, asking more in-depth questions related to the different features of the prototype. During this test, students and mental healthcare professionals were also asked about the small interventions and triggers that they would expect from the app. Their suggestions are collected in 4.5 Triggers.

One of the students that tested the app suggested including a voice note feature: "*Sometimes I don't want to spend the time writing about my day, it takes too much time, it would be nice if you could record voice notes instead*". This feature was designed and included in the next prototype.

The profile tab seemed to be overwhelming for some students, they suggested some changes to have a better overview of the options available. The red buttons, representing

irreversible actions (except log out) were getting too much attention from the students.

An international student commented on using the initials for the days of the week: "*I often struggle when the days of the week are represented only the initials, it takes me some seconds to identify the days, but whenever I read 'Mon, Tue, etc' is much easier*". Some other students, when asked specifically about this, agreed, thus, it was implemented in the last prototype. For native speakers might not be an issue but since this app is meant for danish and international students, the change was made.

Some students pointed out the font size being too small and others suggested using different colors for the stats and other small changes.

The feedback received from Giovanna Vilaza, the professional at CACHET expert in design ethics, oscillated towards providing instructions for first-time users. The amount of new information for first-time users can be overwhelming and increase dropout rates. She also gave feedback and suggested small changes to the new informed consent. Lastly, she suggested differentiating more 'Today' from 'Progress' in the home tab, as it could lead to confusion to students thinking they belong to the same category, hence requiring the same actions.

Mental healthcare professionals provided positive feedback in terms of the app design: "*It's looking really good – you've chosen nice simple images and colours that I think promote a calming experience. I really like that you give the student a choice on which stats they want to receive feedback on. That way, for example, a student who is happy to not be very physically active does not get reminders to get moving. This makes the feedback meaningful for them, rather than intrusive*'. They also provided suggestions and measures for the small interventions collected in 4.5 Interventions.

4.4 Final Iteration. Final prototype

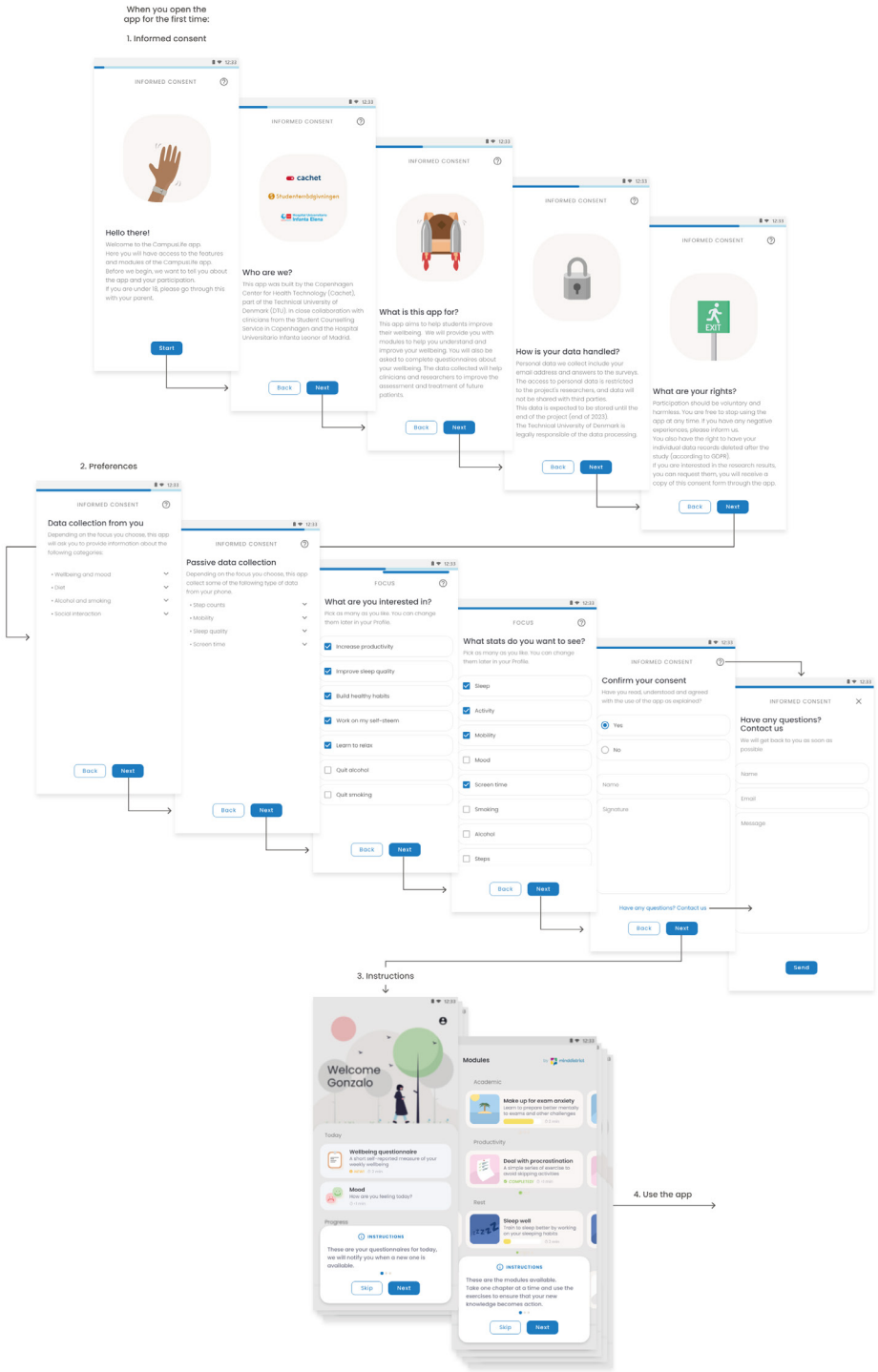
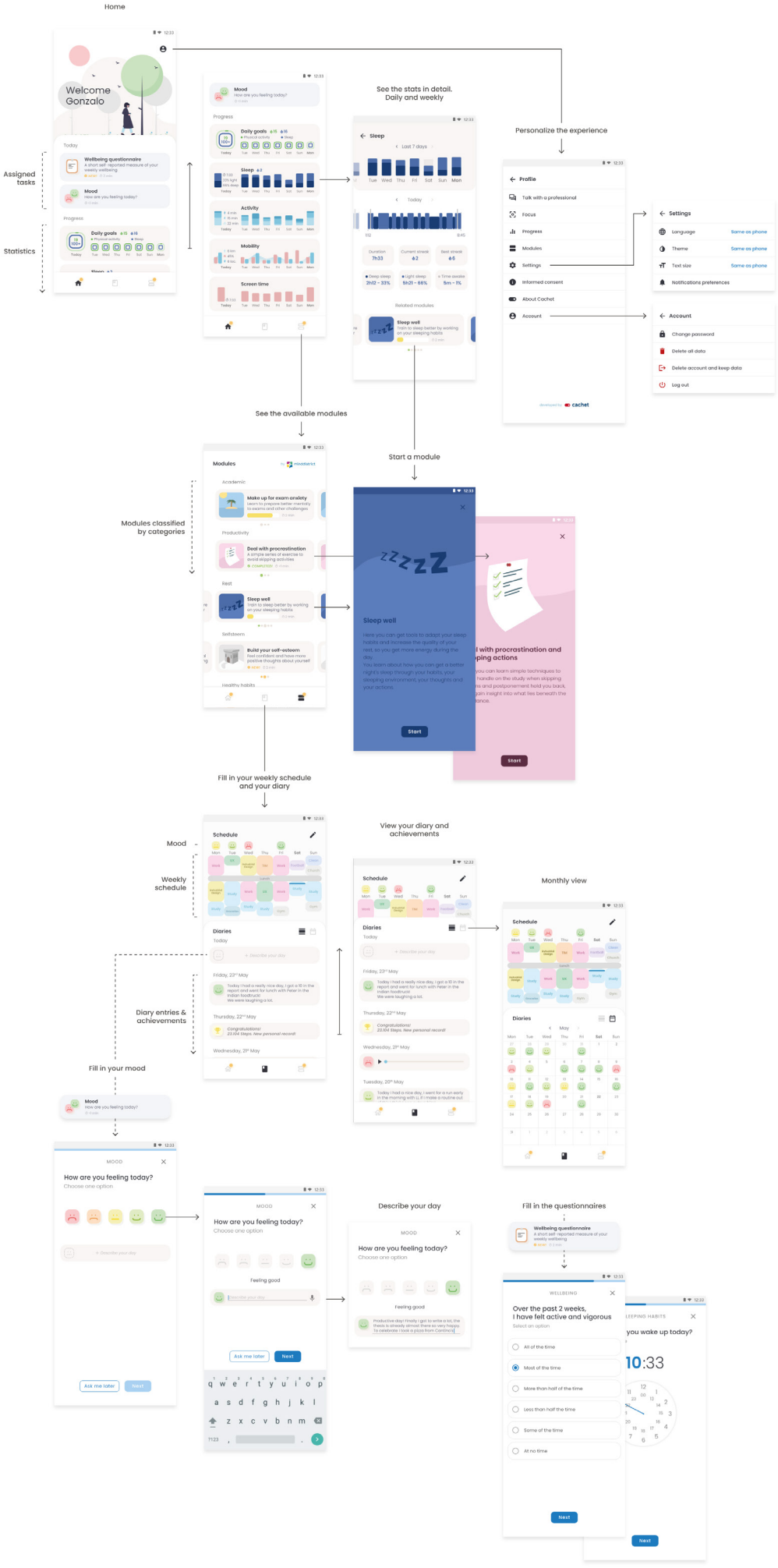


Figure 37: Final prototype wireframes


Home
Welcome Gonzalo
Assigned tasks
Statistics
See the stats in detail. Daily and weekly
Personalize the experience
See the available modules
Start a module
Modules classified by categories
Fill in your weekly schedule and your diary
View your diary and achievements
Monthly view
Mood
Weekly schedule
Diary entries & achievements
Fill in your mood
Describe your day
Fill in the questionnaires
Sleep well
Start

The students, when navigating through the app for the first time, based on the feedback, will now get instructions or tutorial screens like the provided examples.

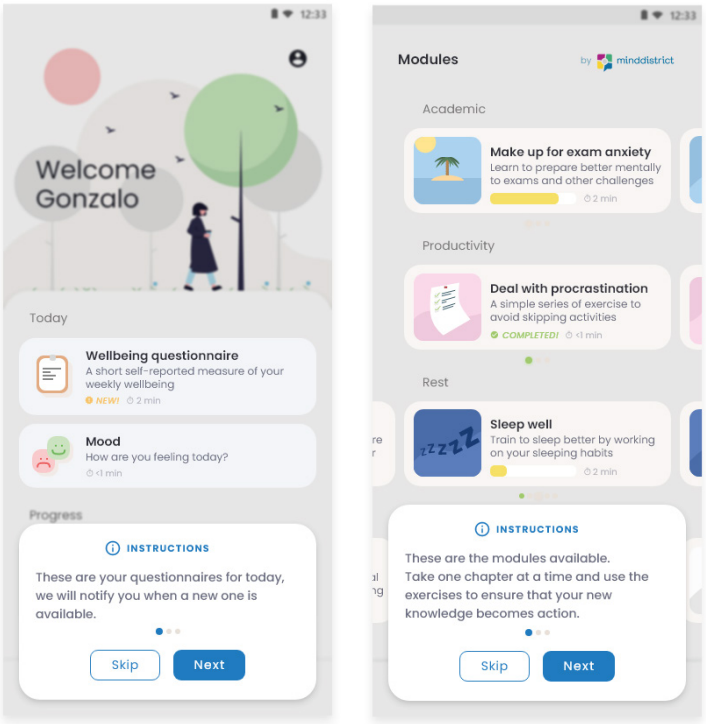


Figure 38: Instructions examples

In the home tab, the 'Today' tasks were changed in color to differentiate better with the 'Progress' stats.

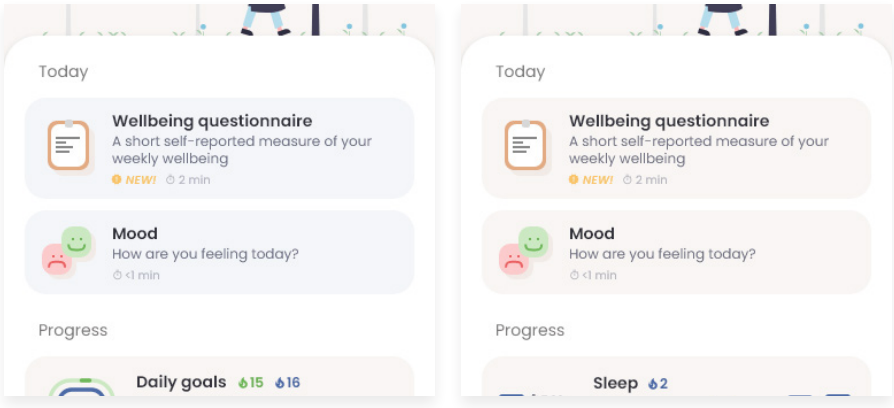


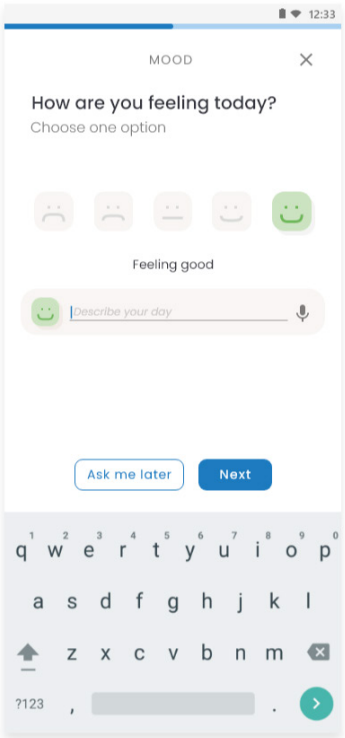
Figure 39: New and previous color.

In the same tab, the graph colors were also changed following a suggestion from a student, that pointed out that the color difference between the sleep graph and the rest was not consistent (see figure 40.

Based on the students' feedback, a voice note feature was added to the diary, the changes

are reflected both in the mood questionnaire and the diaries page. The design of the monthly view of the diaries responses was also implemented.

Figure 40: New stats colors.



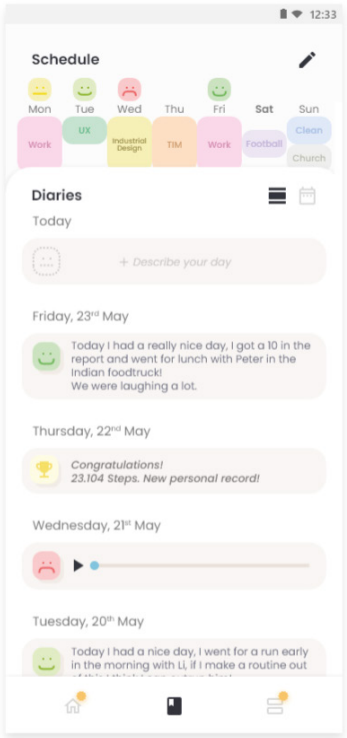


Figure 41: Voice note feature.

Based on the students' feedback the days of the week were changed from 'M, T, W, T, F, S & S' to 'Mon, Tue, Wed, Thu, Fri, Sat & Sun'. These changes are visible in the statistics of the home tab, the individual statistics page, and the schedule.

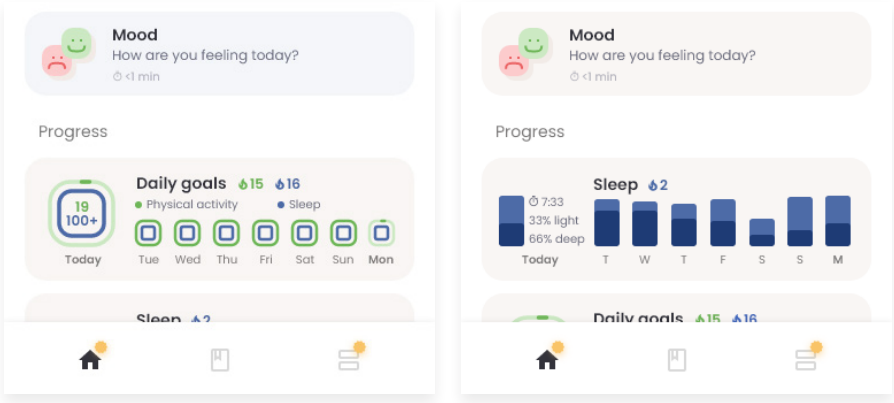


Figure 42: New day abreviation and previous day abreviation.

The profile tab distribution was rearranged, classifying some of the options under 'Settings' and 'Account'. This gave a cleaner look to the main profile tab while hiding the red buttons that were dragging too much attention from the students.

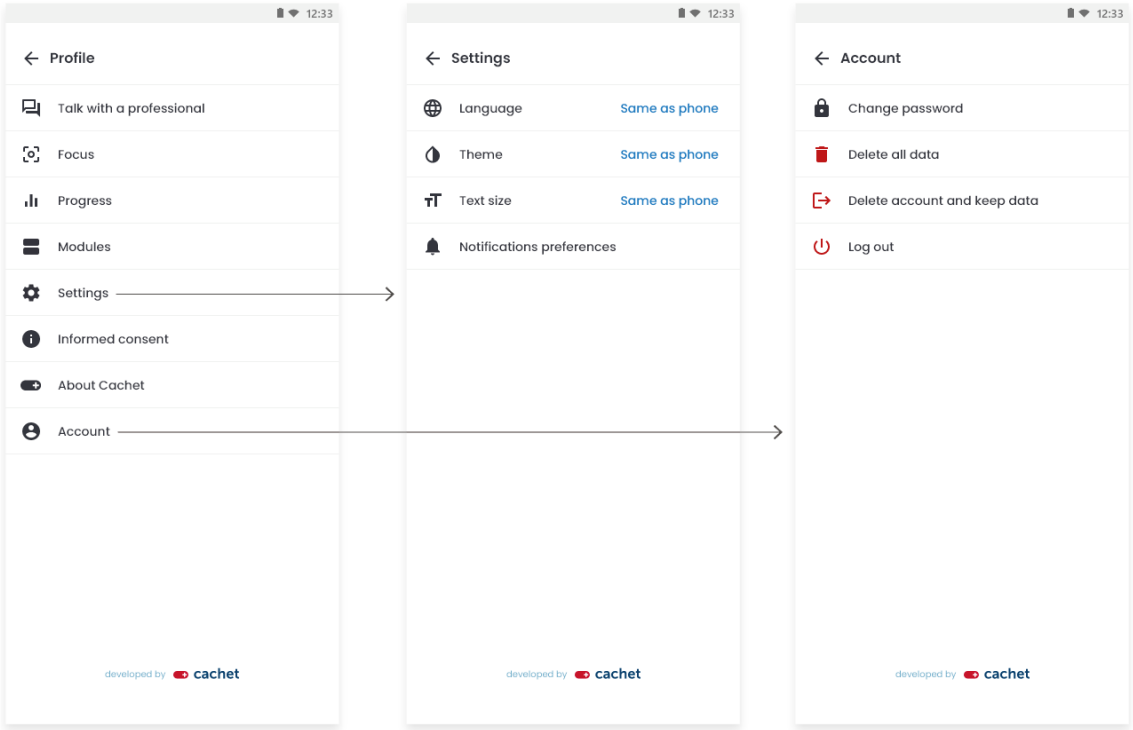


Figure 43: New profile distribution.

Based on the student feedback, the font size was increased again in some of the screens.

4.4.1 Final Test

The final test, once all the changes from the second test were implemented, was a usability test. The System Usability Scale (SUS) is the most common and standardized questionnaire to measure usability, is a 10 question assessment that provides a reliable tool to measure usability: the score of this test is measured from 0 to 100, and a good design is considered that should score at least 70-75 points (M. Deininger, 2021 I).

The score obtained in the test was 82.5/100. Which is considered an above-average (68) score. This score is more significant due to the short exposure of the users to the app: users with longer exposure to the product tend to give betters scores (M. Deininger, 2021 I). The questions and answers of the SUS can be found in the Appendix.

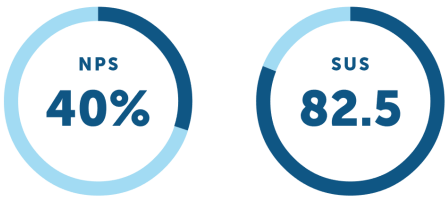


Figure 44: Net Promoter Score and System Usability Score.

Finally, they were asked for the Net Promoter Score (NPS) under the question: *"How likely is it that you'll recommend the app to other students?"* from 0 (not at all likely) to

10 (extremely likely). This question is used to estimate loyalty and general satisfaction. The score obtained was NPS=40%, which compared to the 21% of average in software products can be considered a good score (M. Deininger, 2021 II).

A final heuristic test was also carried out by the author (see Appendix B.6). Heuristic evaluations and user testing often find usability problems overlooked by the other method, thus experts recommend running both tests (M. Deininger, 2021 II). In general terms, the results obtained were positive, however, there were still some areas of improvement. The best practice would be to correct the flaws detected and apply them in a last iteration. Part of the questions included in the heuristic questionnaire are regarding animations, response times, visual feedback, or prompts that need to be implemented when the app is coded, hence, it would be interesting to have these questions in mind during the development process and run the test again once the app is fully functional.

4.5 Interventions

The app is meant to include small automated interventions to help students improve their wellbeing. Big interventions will be provided by healthcare professionals. Thus, the app should include the needed triggers to start both intervention processes:

- Small interventions. Changing the user experience to adapt to the triggered intervention. Examples of these changes could be suggesting a module based on the recent activity level or prompt another questionnaire related to a bad score in a concrete section of the general wellbeing questionnaire.

- Big interventions. Triggering an alarm in the clinician's platform informing about the event that lead to that alarm and providing information related to the student's wellbeing.

During the brainstorming session in the second test, stakeholders were asked to provide examples of triggered small interventions that they think would be useful to be provided by the app for the students' wellbeing. These are some of the examples brainstormed during the co-creation sessions:

- Related to exams: when the examination period approaches, suggest modules related to exam anxiety or productivity.

- Co-relate mood with exercise when possible: if exercise levels are high and mood results are great as well, encourage to keep both levels up with a motivational message.

- If the sleep scores are low, suggest sleep-related modules or give simple tips as notifications. Related to sleep, it would be interesting if the app could recognize bad sleeping habits from the smartphone sensing and make a specific suggestion (e.g. if the student is using his/her phone right before going to sleep, or if they are going to sleep very late). A collection of these suggestions can be found in Dr. Miguel Alvarez de Mon's paper about the treatment of insomnia (Alvarez-Mon MA, 2019).

- If their home-stay percentage is high, suggest the user a concrete activity to go outside.

- If the mood responses follow a certain pattern (e.g. being in a bad mood every

Monday), suggest the user review their schedule for that day and include an activity they enjoy, or perhaps make a change in the activities they have.

• When the screen time is above the recommended/average values, suggest a specific activity or a related module.

• Encourage and congratulate students when they reach their established goals in terms of, for example, sleep or steps.

Related to the questionnaire responses, Dr. Miguel A. de Mon provided examples of triggers and interventions based on the questionnaires responses (see B. Appendix for the questionnaires):

• For the questionnaire PHQ-9, regarding general wellbeing and depression: if the score is between 0-4 it is fine, 5-9 "wait and see" repeating the questionnaire ahead in time, 10-14 suggest modules or activities, 15-19 contact the Student Council, 20-27 contact the danish healthcare system. Anyhow, if the user scores any point in question 9, that regards self-harm, contact a mental healthcare professional inmediately.

• For the Rosenberg Self-esteem scale: if the score is above 30, it means a high self-esteem, no action is needed; if the score is between 20 and 30, suggest a module regarding self-esteem; if the score is below 20, contact the Student Council.

• For the EAT-26, a test regarding eating attitudes: if the score is between 0-10, it is normal; if the score is above 10 the procedure will be to suggest a related module and repeat the questionnaire ahead in time; if the score keeps above 10, contact the Student Council.

• For the CAGE questionnaire, a screening test for problem drinking and potential alcohol or drug problems: if the user scores 2, recommend a module; if the user scores more than two, contact a healthcare professional.

• For the WHO-5, also regarding general wellbeing, alternate with the PHQ-9: if the user scores below 13, trigger the PHQ-9 and act depending on the score in this questionnaire.

• For the PHQ-15, a questionnaire regarding stress and anxiety: if the score is between 0-5, it is normal; if the score is between 6-10, recommend a module related to the topic or a 'learning to relax' module; if the score is between 11-15, contact a mental healthcare professional.

• If the mobile sensing or questionnaires about that matter indicates low sociability, or self-isolation, suggest an NIH toolbox (NIH, 2015).

Freja Petersen, from the Student Council, also provided examples of potential interventions based on diverse factors:

• Related to course work: after delivering a questionnaire related to how the student is managing course work (ex: on top of it/coping/struggling/falling behind/failed a class or assignment), there could be a trigger to contact the studievejledning (the guidance counselors) on their campus for support. Or a link to their college information regarding re-examinations etc. Another option could be to suggest a few basic study skills tools – like a focus timer, a to-do list to keep track of what

is pending/done/blocked tasks, suggestions for how to set up a study schedule or optimize your study environment. This could be included in a module.

• Related to sociability: if they are feeling isolated (deducted perhaps by a social connection questionnaire or mobile sensing), there could be a trigger to show options for social/college events or societies to attend or reach out to. Like college-specific tutors, mentors, clubs & societies.

• Suggestion to contact the Student Council: ideally there would also be a button to contact SRG – both as a default for everyone, but also as a function that is suggested if their emotional wellbeing drops significantly.

• Learning to relax: if their activity level is very high, or they report stress, perhaps, apart from the relax modules, include a number of sound files with guided relaxation exercises to suggest to the student.

4.6 Data Collection

For the app designed in this report, the data collection will have two main channels: automatic sensing and self-reported data. This will follow a similar structure to the figure below.

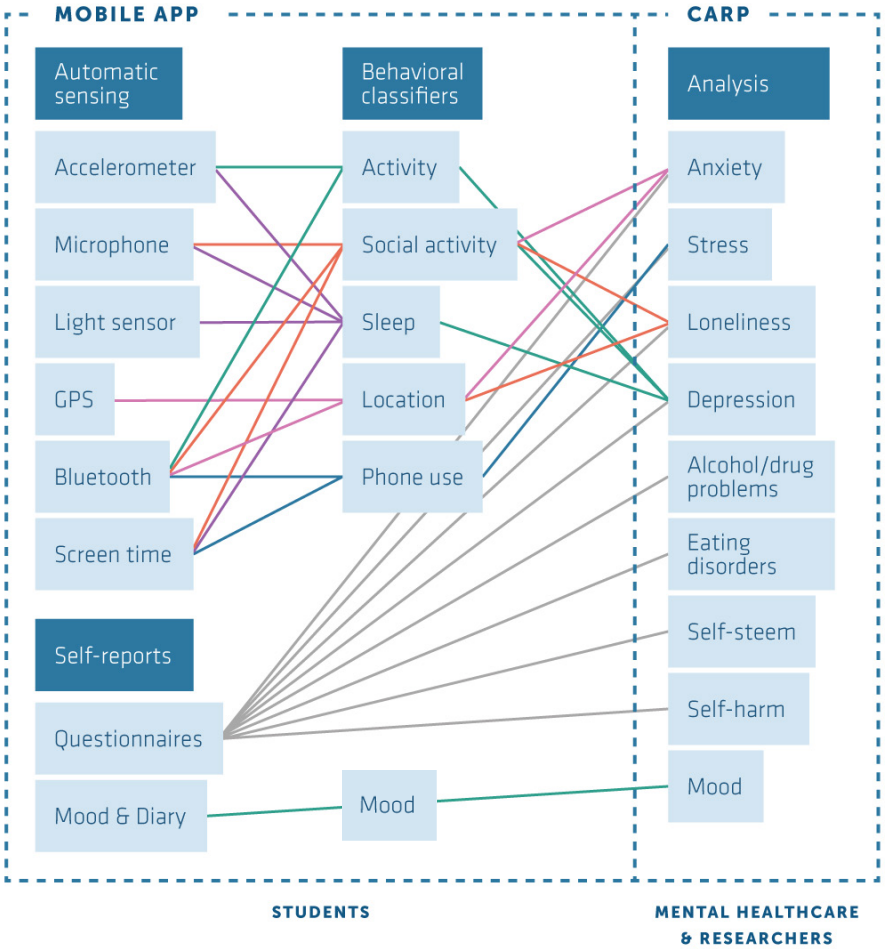


Figure 45: App architecture: sensing, self-reports and analysis system.

Self-reported data

The self-reported data consists of the questionnaires and the mood/diaries reports. The questionnaires' architecture will depend on three factors:

1. The user preferences indicated in the app setup.

2. The responses that students give to the questionnaires, that can trigger other questionnaires (see 4.5 Interventions).

3. The data collected from the automatic sensing, that can also trigger different questionnaires.

The set of questionnaire selected is meant to cover the whole spectrum of mental health issues suffered by students. The selection has been designed by Dr. Miguel Alvarez de Mon and contains the following questionnaires (see B. Appendix for the questionnaires):

- The PHQ-9, regarding mental wellbeing in general and depression.
- The Rosenberg Self-esteem scale.
- The EAT-26, regarding eating attitudes
- The CAGE, a screening test for problem drinking and potential alcohol or drug problems.
- The WHO-5, regarding general wellbeing and meant to be alternated with the PHQ-9.
- The PHQ-15, questionnaire regarding stress and anxiety.

Automatic sensing

The automatic sensing (or passive data), will be collected from the smartphone sensors and translated into behavioral classifiers by the app. The sensors to be employed for the passive data collection are the following:

1. Accelerometer
2. Microphone
3. Light sensor
4. GPS
5. Bluetooth
6. Screen time

The data collected by these sensors will then be translated as shown in the figure into the following behavioral classifiers:

- activity,
- social activity,
- sleep,

- location,
- and phone use data.

From the student's point of view, the data will be displayed (if desired by the user) in the statistics (home) tab, where the students can analyze and self-assess their own mental health.

This data will also be available for mental healthcare professionals and researchers in the Carp platform (provided by Cachet), where they will be able to analyze, based on the data, the student's mental health issues. The data will also be supplemented with the questionnaires and mood answers. Furthermore, as described in 4.5 Interventions, the architecture provides the mental healthcare professional with triggers that can set alarms for them to act in certain cases.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5. Discussion

5.1 Personal Reflection

When deciding my thesis topic, a lot of factors came into consideration. However, there was one above the others: I wanted to design something that could potentially make an impact on people, and being a Student Designer at CACHET, was the perfect setup for that matter.

During the first meetings with my supervisor at CACHET, discussing the topic and focus for this thesis project, we strongly agreed that in order to carry out the best user-centered design process possible, I needed to have access to the users.

There were other eHealth projects proposed at that time that would have probably involved visiting hospitals and having contact with doctors and patients, however, due to the current pandemic situation, we did not want to rely our contact with the users on visits to the hospital, since the COVID-19 situation could rapidly change - as it ended up happening - leaving us without the possibility to contact the users. Instead, we decided to go with the CampusLife project, which I strongly believe gravitated towards a better solution.

Being a student myself was a deciding factor to choose to focus on this issue among others. It brought me closer to the topic, making it easier for me to relate to the problems students are facing, as I was able to take into consideration my personal experience as a student in Denmark along with the experience of other classmates that I have shared my time with during my Bachelor and Master.

However, mental health was then an unknown topic for me. Luckily, as I mentioned before, CACHET's environment as a research center for health technology represented the perfect setup, as it provided me with tools, papers, and reasearch in related topics.

The endless amount of papers and literature regarding related topics quickly felt overwhelming. Entering into a new and unknown topic where a paper leads you to another and so on, where everything seems important for the purpose supposed a challenge in terms of being able to realize when to stop. Honestly, looking backwards, I realize that I spent a lot of time in the process digging and reading new papers. Instead, if I had to do it again, I would probably start the design process earlier and continue reading literature in the meantime, instead of waiting until I had things clear enough to start the process.

Anyhow, after reviewing the literature and interviewing the healthcare professionals it became clear that students facing mental health problems represented a challenge for educational institutions and the healthcare system. This challenge is, indeed, an important ongoing and growing problem that needs solutions.

Mental health in general, and mental health among students in particular, were unknown topics for me at the beginning. Hence, the importance of including the stakeholders of student mental health was highlighted since the beginning, not only to carry a proper user-centered design but also to learn as much as possible about the topic given the short period of time that represents a master thesis. Fortunately, two mental health professionals representing the Student Council and the Spanish Mental Healthcare system accepted to help in the process of defining the problem statement and designing the best possible

solution for students. Being a student myself gave me easy access to other students, the other main stakeholder. And as mentioned before, working at Cachet I had access to the third main stakeholder in digital mental health, the developers of mHealth.

However, despite being a student myself, in the early stages of the project, I stumbled across an ethical obstacle: for research purposes, it was interesting for me to interview students that were suffering or had suffered from mental health issues in order to extract more for the interview and get a better understanding of the problem, however, it did not seem ethical to ask the student council to get these students in touch with me, as I was sure that if I were in the same position as them, I would prefer to speak only with professionals.

And furthermore, was I skilled to talk about these problems with students that had suffered or were suffering from these conditions without making it worst for them? After deliberating with the supervisors, we agreed that in order to speak with this kind of patients, I needed to be trained to do so, as it can be challenging sometimes, and even with the best of intentions, things can easily go bad. However, training for this purpose was considered to be out of the scope of this project. The solution remaining was to speak with students with mild problems instead, or students that I already knew and were comfortable speaking about their issues with me.

When the initial interviews took place, all the pieces seemed to fit together. Regarding the interviews with students, a pattern of issues and symptoms was clearly recognizable, and even more, they were problems and symptoms I could easily feel identified with, which I think helped towards developing a suitable solution.

The interviews with the mental health professionals developed as I was advancing through the process. The initial interviews, as I said before, gave me the best possible overview of the problem and helped me understand the process, while the next interviews helped refine the design taking decisions based on their experience as mental health professionals. I think their contribution gave important value and validation to the project.

As a designer, the design phase was the stage I was most interested in. But, nevertheless, I decided to not start sketching until the initial interviews were over, in order to not be biased by my preconception of an app for students' mental health. Since the app prototype is the main deliverable of the master thesis, it was not the most comfortable position. However, I believe that this decision helped build a design that followed the requirements set in the initial stages more than the preconception I had of students' mental health.

During the iteration phases of the prototyping process, I tried to involve the stakeholders as much as possible, since the feedback all provided was very valuable. In total, three prototype versions were designed, with two feedback sessions and a usability test. The length of the thesis did not allow to carry more tests and feedback sessions, but I believe that the results would have been better if there was enough time to do a fourth prototype, based on a last feedback session where the students could compare two versions of the same feature and do an a/b testing. There were some changes in the last prototype that could not be validated individually since the third prototype was only tested in terms of general usability.

Overall, I am happy with the results obtained, and the feedback obtained from the mental health professionals was also very positive. I believe, and so the clinicians, that if the CampusLife project is to be continued, this app could really make an impact in the lives of

students. And that was the desired outcome at the beginning of the project.

5.2 Future works

This thesis project represents the initial step of the CampusLife project, a continuation of the StudentLife project (R. Wang et al., 2014), the name of an international collaboration that also involves universities from the US, the UK, and EU that developed a continuous sensing app to monitor the impact of workload on stress, sleep, activity, mood, sociability, mental well-being and academic performance in a daily and weekly basis (see 2.2 Related Work).

The CampusLife project aims to provide an alternative or supplementary solution to traditional healthcare by offering students a mobile-based intervention app to help them improve their mental health. The StudentLife study, nevertheless, provided a solid ground to further develop this concept of adding mobile aided interventions guided by professionals on students' mental health while maintaining the digital phenotyping architecture established by this precursor study. Thus, the future works related to this thesis will be facing in that direction.

The idea at CACHET with this kind of projects, as they lack external dedicated funding, is to be developed by successive master thesis projects carried out by students with different backgrounds depending on the kind of thesis required.

As mentioned before, this master thesis is the starting point for the project. The idea behind this thesis was to provide the necessary clinical background to develop the CampusLife project and set up the design guidelines for the project.

Based on the 'modus operandi' at CACHET, the timeline of the project and future works to develop are represented in the following figure.

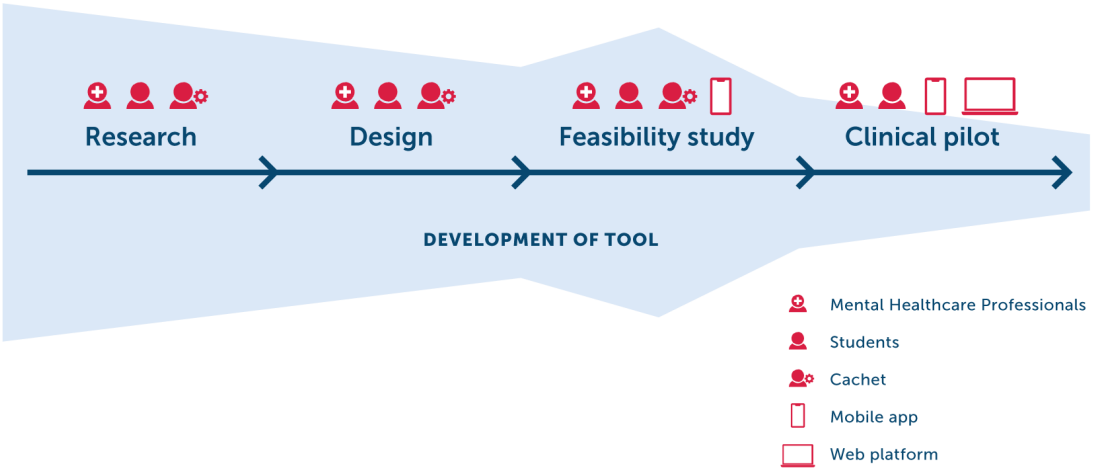

Figure 46: Timeline.

The next step would be to implement the prototyped mock-up into a working app. This step will require to set collaboration between the Student Council and CACHET in order to integrate the modules from Minddistrict, and the triggers designed by clinicians and

students. During this step, the app must be integrated into the CARP platform (carp.cachet.dk) to provide the healthcare professionals and researchers with a platform to study the students' progress and data by the translated digital phenotyping. An important part of the process will require focusing on the privacy policy and issues that might arise and elaborate subsequently a complete informed consent.

Once the app is running, the next step would be to carry out a feasibility study with a small sample of students and healthcare professionals to analyze the benefits, side effects, and risks of the app. This study will provide the clinical evidence needed to be recognized as a mental health solution for students. The users recruited will be students at DTU. However, if a bigger representative sample is needed, platforms for digital psychiatry projects recruitment ire a common tool to provide the needed sample (DigitalPsych, 2020). This feasibility study should also focus in the usability of the app, asking the students to provide feedback on the newly programmed app in order to continue the iteration process before the final release.

After the feasibility study is completed, running a clinical pilot of the app fully integrated with the clinicians' web platform will be the next step. The purpose of this second study will be to replicate the app in a real-life scenario with real patients in order to acquire information about the app and the integration with Carp before releasing it to the public.

When successful, the final step will be to release it publicly, and together with the Student Council and Cachet, inform universities about the tool in order to facilitate and unclog their mental health services. The technical support to fix problems and bugs will be taken care of by Cachet.

6. Conlusion

During the course of this project, through the data analyzed during the research and the interviews conducted with healthcare professionals and students, we can dictate that mental health among students is a real problem, and the recent COVID-19 has increased the demand for mental health services even more, making this a growing problem that needs to be faced.

This problem represents an opportunity for new forms of mental health interventions since traditional healthcare is not able to keep up with the demand for mental health services by students. Countries worldwide are becoming aware of this problem: in Denmark, the gap between the students with mental health issues and the students being treated is estimated to be over 50.000 (EVA,2015); other developed countries like the USA and South Korea are raising awareness due to the increasing suicide rates, and in less severe cases, the increasing college dropout rates.

This project is the continuation of the StudentLife study, a project that monitored students' lifestyle behaviors and collected data to understand the effects of these behaviors on the academic outcomes. Taking this study as the base, this thesis aimed to design an app that following the same data collection architecture could also give feedback and provide mobile-based interventions to students.

One of the biggest challenges in the design of these apps - and digital health in general - is achieving engagement by the users and lowering the dropout rates. To achieve this, students were an active and important part of the user-centered design process.

A well-conducted user-centered design must count on the entire spectrum of stakeholders, and this project did count with the participation of students, mental healthcare professionals, and eHealth apps developers. Hence, the final prototype designed is the result of the co-creation sessions conducted with the stakeholders.

The result of this design process is an app that aims to provide students with tools to help them manage their mental health. The features provided are a combination of tools already used in patient treatment by mental healthcare professionals and features desired by the students. Some of the tools provided are modules related to mental health topics, a diary, a schedule, data visualization, and small automated interventions based on the mobile sensing and questionnaire responses.

However, there is still work to be done before the app gets released, between which stands out the feasibility study and the clinical pilot, that will provide clinicians and developers with the information needed to evaluate the risks and benefits within the use of the app by students.

This kind of technologies offer new possibilities in mobile patient treatment. Experts suggest that in a near future, using the data collected by mobile sensing, your smartphone will be able to forecast your mood, helping you stop bad moods even before they strike. These types of mobile-based interventions could potentially improve users' mental health and its impact on academic performance or even help prevent suicide.


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B. Appendix

B.1 Acronyms

CACHET - Copenhagen Center for Health Tecnology
WHO - World Health Organization
ILO - Intended Learning Objectives
UCD - User Centered Design
SM - Scrum Master
PO - Product Owner
SDT - Scrum Development Team
PDR - Project Definition Report
SRG - Studenterrådgivningen - Student Council
SUS - System Usability Scale
NPS - Net Promoter Score

B.2 Student Council First Interview Questions

1. How is the process for a student suffering from a mental condition, starting the moment they need help and ending when they are healthy again?

2. What do students suffer the most from? How do they deal with those?

3. What parts of the process (Question 1) are automated?

4. Is there any automatically generated feedback that you collect?

5. What values/data do you track/collect during the process?

6. What value can an app bring to this process?

7. Do you send out wellbeing questionnaires? How often? Is automatically or manually reviewed?

8. Are they any digital solutions that the Student Council is using already or planning to use?

B.3 Dr. Miguel Alvarez de Mon First Interview Questions

1. What area are you focused in?

2. What is the kind of cases that you have with students?

3. How is the process for a student suffering from a mental condition, starting the moment they need help and ending when they are healthy again?

4. How often do you meet with the patients?

5. What do students suffer the most from? How do they deal with those?

6. What parts of the process (Question 1) are automated?

7. Is there any automatically generated feedback that you collect?

8. What values/data do you track/collect during the process?

9. What value can an app bring to this process?

10. Do you send out wellbeing questionnaires? How often? Is automatically or manually reviewed?

11. Are they any digital solutions that the Hospital Universitario Infanta Sofia is using already or planning to use?

B.4 System Usability Scale

1. I think that I would like to use this system frequently.
Strongly agree: 25%, Agree: 50%, Not agree nor disagree: 25%, Disagree: 0%, Strongly disagree: 0%

2. I found the system unnecessarily complex.
Strongly agree: 0%, Agree: 0%, Not agree nor disagree: 0%, Disagree: 40%, Strongly disagree: 60%

3. I thought the system was easy to use.
Strongly agree: 80%, Agree: 20%, Not agree nor disagree: 0%, Disagree: 0%, Strongly disagree: 0%

4. I think that I would need the support of a technical person to be able to use this system.
Strongly agree: 0%, Agree: 0%, Not agree nor disagree: 20%, Disagree: 0%, Strongly disagree: 80%

5. I found the various functions in this system were well integrated.
Strongly agree: 20%, Agree: 60%, Not agree nor disagree: 20%, Disagree: 0%, Strongly disagree: 0%

6. I thought there was too much inconsistency in this system.
Strongly agree: 0%, Agree: 0%, Not agree nor disagree: 20%, Disagree: 40%, Strongly disagree: 40%

7. I would imagine that most people would learn to use this system very quickly.
Strongly agree: 40%, Agree: 40%, Not agree nor disagree: 20%, Disagree: 0%, Strongly disagree: 0%

8. I found the system very cumbersome to use.
Strongly agree: 0%, Agree: 0%, Not agree nor disagree: 20%, Disagree: 20%, Strongly disagree: 60%

9. I felt very confident using the system.
Strongly agree: 80%, Agree: 20%, Not agree nor disagree: 0%, Disagree: 0%, Strongly disagree: 0%

10. I needed to learn a lot of things before I could get going with this system
Strongly agree: 60%, Agree: 20%, Not agree nor disagree: 0%, Disagree: 0%, Strongly disagree: 20%

B.5 Heuristic Test

#	Review Checklist	Yes	No	N/A	Comments
1.1	Does every display begin with a title or header that describes screen contents?	☑	○	○	
1.2	Is there a consistent icon design scheme and stylistic treatment across the system?	☑	○	○	
1.3	Is a single, selected icon clearly visible when surrounded by unselected icons?	☑	○	○	
1.4	Do menu instructio prompts, and error messages appear in the same place (s) on each menu?	☑	○	○	
1.5	In multipage data entry screens, is each page labeled to show its relation to others?	○	○	☑	
1.6	If overtype and insert mode are both available, is there a visible indication of which one the user is in?	○	○	☑	
1.7	If pop-up windows are used to display error messages, do they allow the user to see the field in error?	○	○	☑	
1.8	Is there some form of system feedback for every operator action?	☑	○	○	
1.9	After the user completes an action (or group of actions), does the feedback indicate that the next group of actions can be started?	☑	○	○	
1.10	Is there visual feedback in menus or dialog boxes about which choices are selectable?	☑	○	○	
1.11	Is there visual feedback in menus or dialog boxes about which choice the cursor is on now?	○	☑	○	
1.12	If multiple options can be selected in a menu or dialog box, is there visual feedback about which options are already selected?	☑	○	○	
1.13	Is there visual feedback when objects are selected or moved?	☑	○	○	
1.14	Is the current status of an icon clearly indicated?	☑	○	○	

#	Review Checklist	Yes	No	N/A	Comments
1.15	Is there feedback when function keys are pressed?	○	○	☑	
1.16	If there are observable delays (greater than fifteen seconds) in the system's response time, is the user kept informed of the system's progress?	○	○	☑	
1.17	Are response times appropriate to the task?	○	○	☑	
1.18	Typing, cursor motion, mouse selection: 50-1 50 milliseconds	○	○	☑	
1.19	Simple, frequent tasks: less than 1 second	○	○	☑	
1.20	Common tasks: 2-4 seconds	○	○	☑	
1.21	Complex tasks: 8-12 seconds	○	○	☑	
1.22	Are response times appropriate to the user's cognitive processing?	○	○	☑	
1.23	Continuity of thinking is required and information must be remembered throughout several responses: less than two seconds.	○	☑	○	
1.24	High levels of concentration aren't necessary and remembering information is not required: two to fifteen seconds.	☑	○	○	
1.25	Is the menu-naming terminology consistent with the user's task domain?	☑	○	○	
1.26	Does the system provide *visibility*: that is, by looki , can the user tell the state of the system and the alternatives for action?	☑	○	○	
1.27	Do GUI menus make obvious which item has been selected?	○	○	☑	
1.28	Do GUI menus make obvious whether deselection is possible?	○	○	☑	
1.29	If users must navigate between multiple screens, does the system use context labels, menu maps, and place markers as navigational aids?	☑	○	○	

2. Match Between System and the Real World

The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

#	Review Checklist	Yes	No	N/A	Comments
2.1	Are icons concrete and familiar?	☑	○	○	
2.2	Are menu choices ordered in the most logical way, given the user, the item names, and the task variables?	○	☑	○	
2.3	If there is a natural sequence to menu choices, has it been used?	○	○	☑	

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2.4	Do related and interdependent fields appear on the same screen?	✓ o o	
2.5	If shape is used as a visual cue, does it match cultural conventions?	o o ✓	
2.6	Do the selected colors correspond to common expectations about color codes?	o ✓ o	
2.7	When prompts imply a necessary action, are the words in the message consistent with that action?	o o ✓	
2.8	Do keystroke references in prompts match actual key names?	o o ✓	
2.9	On data entry screens, are tasks described in terminology familiar to users?	✓ o o	
2.10	Are field-level prompts provided for data entry screens?		
2.11	For question and answer interfaces, are questions stated in clear, simple language?	✓ o o	
2.12	Do menu choices fit logically into categories that have readily understood meanings?	✓ o o	
2.13	Are menu titles parallel grammatically?	✓ o o	
2.14	Does the command language employ user jargon and avoid computer jargon?	✓ o o	
2.19	Does the system automatically enter leading or trailing spaces to align decimal points?	o o ✓	
2.20	Does the system automatically enter a dollar sign and decimal for monetary entries?	o o ✓	

#	Review Checklist	Yes No N/A	Comments
2.21	Does the system automatically enter commas in numeric values greater than 9999?	o o ✓	
2.22	Do GUI menus offer activation: that is, make obvious how to say *"now do it"*?	✓ o o	
2.23	Has the system been designed so that keys with similar names do not perform opposite (and potentially dangerous) actions?	✓ o o	
2.24	Are function keys labeled clearly and distinctively, even if this means breaking consistency rules?	✓ o o	

3. User Control and Freedom

Users should be free to select and sequence tasks (when appropriate), rather than having the system do this for them. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Users should make their own decisions (with clear information) regarding the costs of exiting current work. The system should support undo and redo.

#	Review Checklist	Yes No N/A	Comments
3.1	If setting up windows is a low-frequency task, is it particularly easy to remember?	o o ✓	
3.2	In systems that use overlapping windows, is it easy for users to rearrange windows on the screen?	✓ o o	
3.3	In systems that use overlapping windows, is it easy for users to switch between windows?	o ✓ o	
3.4	When a user's task is complete, does the system wait for a signal from the user before processing?	✓ o o	
3.5	Can users type-ahead in a system with many nested menus?	o o ✓	
3.6	Are users prompted to confirm commands that have drastic, destructive consequences?	o o ✓	
3.7	Is there an "undo" function at the level of a single action, a data entry, and a complete group of actions?	o ✓ o	
3.8	Can users cancel out of operations in progress?	o ✓ o	
3.9	Are character edits allowed in commands?	o o ✓	
3.10	Can users reduce data entry time by copying and modifying existing data?	o o ✓	
3.11	Are character edits allowed in data entry fields?	o o ✓	
3.12	If menu lists are long (more than seven items), can users select an item either by moving the cursor or by typing a mnemonic code?	o ✓ o	
3.13	If the system uses a pointing device, do users have the option of either clicking on menu items or using a keyboard shortcut?	o o ✓	
3.14	Are menus broad (many items on a menu) rather than deep (many menu levels)?	o ✓ o	
3.15	If the system has multiple menu levels, is there a mechanism that allows users to go back to previous menus?	✓ o o	
#	Review Checklist	Yes No N/A	Comments

3.16	If users can go back to a previous menu, can they change their earlier menu choice?	☑ ○ ○	
3.17	Can users move forward and backward between fields or dialog box options?	☑ ○ ○	
3.18	If the system has multipage data entry screens, can users move backward and forward among all the pages in the set?	☑ ○ ○	
3.19	If the system uses a question and answer interface, can users go back to previous questions or skip forward to later questions?	○ ☑ ○	
3.20	Do function keys that can cause serious consequences have an undo feature?	○ ☑ ○	
3.21	Can users easily reverse their actions?	○ ○ ☑	
3.22	If the system allows users to reverse their actions, is there a retracing mechanism to allow for multiple undos?	○ ○ ☑	
3.23	Can users set their own system, session, file, and screen defaults?	☑ ○ ○	

4. Consistency and Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

#	Review Checklist	Yes No N/A	Comments
4.1	Have industry or company formatting standards been followed consistently in all screens within a system?	☑ ○ ○	
4.2	Has a heavy use of all uppercase letters on a screen been avoided?	☑ ○ ○	
4.3	Do abbreviations not include punctuation?	☑ ○ ○	
4.4	Are integers right-justified and real numbers decimal-aligned?	○ ○ ☑	
4.5	Are icons labeled?	○ ☑ ○	
4.6	Are there no more than twelve to twenty icon types?	○ ☑ ○	
4.7	Are there salient visual cues to identify the active window?	☑ ○ ○	
4.8	Does each window have a title?	○ ☑ ○	
4.9	Are vertical and horizontal scrolling possible in each window?	○ ☑ ○	
4.10	Does the menu structure match the task structure?	○ ○ ☑	
4.11	Have industry or company standards been established for menu design, and are they applied consistently on all menu screens in the system?	☑ ○ ○	
4.12	Are menu choice lists presented vertically?	☑ ○ ○	
4.13	If "exit" is a menu choice, does it always appear at the bottom of the list?	☑ ○ ○	
4.14	Are menu titles either centered or left-justified?	☑ ○ ○	
4.15	Are menu items left-justified, with the item number or mnemonic preceding the name?	○ ○ ☑	
4.16	Do embedded field-level prompts appear to the right of the field label?	○ ○ ☑	
4.17	Do on-line instructions appear in a consistent location across screens?	☑ ○ ○	
4.18	Are field labels and fields distinguished typographically?	○ ○ ☑	
4.19	Are field labels consistent from one data entry screen to another?	○ ○ ☑	
4.20	Are fields and labels left-justified for alpha lists and right-justified for numeric lists?	○ ○ ☑	
#	**Review Checklist**	**Yes No N/A**	**Comments**
4.21	Do field labels appear to the left of single fields and above list fields?	○ ○ ☑	
4.22	Are attention-getting techniques used with care?	☑ ○ ○	
4.23	Intensity: two levels only	○ ○ ☑	
4.24	Size: up to four sizes	☑ ○ ○	
4.25	Font: up to three	○ ☑ ○	
4.26	Blink: two to four hertz	○ ○ ☑	
4.27	Color: up to four (additional colors for occasional use only)	○ ☑ ○	
4.28	Sound: soft tones for regular positive feedback, harsh for rare critical conditions	○ ○ ☑	
4.29	Are attention-getting techniques used only for exceptional conditions or for time-dependent information?	○ ○ ☑	
4.30	Are there no more than four to seven colors, and are they far apart along the visible spectrum?	○ ○ ☑	
4.31	Is a legend provided if color codes are numerous or not obvious in meaning?	○ ☑ ○	
4.32	Have pairings of high-chroma, spectrally extreme colors been avoided?	☑ ○ ○	
4.33	Are saturated blues avoided for text or other small, thin line symbols?	○ ○ ☑	

4.34	Is the most important information placed at the beginning of the prompt?	o o ✓	
4.35	Are user actions named consistently across all prompts in the system?	o o ✓	
4.36	Are system objects named consistently across all prompts in the system?	o o ✓	
4.37	Do field-level prompts provide more information than a restatement of the field name?	o o ✓	
4.38	For question and answer interfaces, are the valid inputs for a question listed?	✓ o o	
4.39	Are menu choice names consistent, both within each menu and across the system, in grammatical style and terminology?	✓ o o	
4.40	Does the structure of menu choice names match their corresponding menu titles?	✓ o o	
4.41	Are commands used the same way, and do they mean the same thing, in all parts of the system?	✓ o o	
4.42	Does the command language have a consistent, natural, and mnemonic syntax?	o o ✓	
4.43	Do abbreviations follow a simple primary rule and, if necessary, a simple secondary rule for abbreviations that otherwise would be duplicates?	✓ o o	
#	**Review Checklist**	**Yes No N/A**	**Comments**
4.44	Is the secondary rule used only when necessary?	o o ✓	
4.45	Are abbreviated words all the same length?	✓ o o	
4.46	Is the structure of a data entry value consistent from screen to screen?	✓ o o	
4.47	Is the method for moving the cursor to the next or previous field consistent throughout the system?	✓ o o	
4.48	If the system has multipage data entry screens, do all pages have the same title?	✓ o o	
4.49	If the system has multipage data entry screens, does each page have a sequential page number?	o ✓ o	
4.50	Does the system follow industry or company standards for function key assignments?	o o ✓	
4.51	Are high-value, high-chroma colors used to attract attention?	✓ o o	

5. Help Users Recognize, Diagnose, and Recover From Errors

Error messages should be expressed in plain language (NO CODES).

#	Review Checklist	Yes No N/A	Comments
5.1	Is sound used to signal an error?	o o ✓	
5.2	Are prompts stated constructively, without overt or implied criticism of the user?	o o ✓	
5.3	Do prompts imply that the user is in control?	o o ✓	
5.4	Are prompts brief and unambiguous.	o o ✓	
5.5	Are error messages worded so that the system, not the user, takes the blame?	o o ✓	
5.6	If humorous error messages are used, are they appropriate and inoffensive to the user population?	o o ✓	
5.7	Are error messages grammatically correct?	o o ✓	
5.8	Do error messages avoid the use of exclamation points?	o o ✓	
5.9	Do error messages avoid the use of violent or hostile words?	o o ✓	
5.10	Do error messages avoid an anthropomorphic tone?	o o ✓	
5.11	Do all error messages in the system use consistent grammatical style, form, terminology, and abbreviations?	o o ✓	
5.12	Do messages place users in control of the system?	✓ o o	
5.13	Does the command language use normal action-object syntax?	o o ✓	
5.14	Does the command language avoid arbitrary, non-English use of punctuation, except for symbols that users already know?	o o ✓	
5.15	If an error is detected in a data entry field, does the system place the cursor in that field or highlight the error?	✓ o o	
5.16	Do error messages inform the user of the error's severity?	o o ✓	
5.17	Do error messages suggest the cause of the problem?	o o ✓	
5.18	Do error messages provide appropriate semantic information?	o o ✓	
5.19	Do error messages provide appropriate syntactic information?	o o ✓	
5.20	Do error messages indicate what action the user needs to take to correct the error?	✓ o o	
5.21	If the system supports both novice and expert users, are multiple levels of error-message detail available?	o o ✓	

6. Error Prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

#	Review Checklist	Yes No N/A	Comments
6.1	If the database includes groups of data, can users enter more than one group on a single screen?	o o ☑	
6.2	Have dots or underscores been used to indicate field length?	o o ☑	
6.3	Is the menu choice name on a higher-level menu used as the menu title of the lower-level menu?	☑ o o	
6.4	Are menu choices logical, distinctive, and mutually exclusive?	☑ o o	
6.5	Are data inputs case-blind whenever possible?	o o ☑	
6.6	If the system displays multiple windows, is navigation between windows simple and visible?	☑ o o	
6.7	Are the function keys that can cause the most serious consequences in hard-to-reach positions?	☑ o o	
6.8	Are the function keys that can cause the most serious consequences located far away from low-consequence and high-use keys?	☑ o o	
6.9	Has the use of qualifier keys been minimized?	o o ☑	
6.10	If the system uses qualifier keys, are they used consistently throughout the system?	o o ☑	
6.11	Does the system prevent users from making errors whenever possible?	o o ☑	
6.12	Does the system warn users if they are about to make a potentially serious error?	o o ☑	
6.13	Does the system intelligently interpret variations in user commands?	o o ☑	
6.14	Do data entry screens and dialog boxes indicate the number of character spaces available in a field?	o o ☑	
6.15	Do fields in data entry screens and dialog boxes contain default values when appropriate?	o o ☑	

7. Recognition Rather Than Recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

#	Review Checklist	Yes No N/A	Comments
7.1	For question and answer interfaces, are visual cues and white space used to distinguish questions, prompts, instructions, and user input?	☑ o o	
7.2	Does the data display start in the upper-left corner of the screen?	☑ o o	
7.3	Are multiword field labels placed horizontally (not stacked vertically)?	o o ☑	
7.4	Are all data a user needs on display at each step in a transaction sequence?	☑ o o	
7.5	Are prompts, cues, and messages placed where the eye is likely to be looking on the screen?	☑ o o	
7.6	Have prompts been formatted using white space, justification, and visual cues for easy scanning?	☑ o o	
7.7	Do text areas have "breathing space" around them?	☑ o o	
7.8	Is there an obvious visual distinction made between "choose one" menu and "choose many" menus?	☑ o o	
7.9	Have spatial relationships between soft function keys (on-screen cues) and keyboard function keys been preserved?	o o ☑	
7.10	Does the system gray out or delete labels of currently inactive soft function keys?	o o ☑	
7.11	Is white space used to create symmetry and lead the eye in the appropriate direction?	☑ o o	
7.12	Have items been grouped into logical zones, and have headings been used to distinguish between zones?	☑ o o	
7.13	Are zones no more than twelve to fourteen characters wide and six to seven lines high?	o o ☑	
7.14	Have zones been separated by spaces, lines, color, letters, bold titles, rules lines, or shaded areas?	☑ o o	
7.15	Are field labels close to fields, but separated by at least one space?	☑ o o	
7.16	Are long columnar fields broken up into groups of five, separated by a blank line?	o ☑ o	
7.17	Are optional data entry fields clearly marked?	o o ☑	
7.18	Are symbols used to break long input strings into "chunks"?	o o ☑	
7.19	Is reverse video or color highlighting used to get the user's attention?	o o ☑	
7.20	Is reverse video used to indicate that an item has been selected?	o o ☑	
7.21	Are size, boldface, underlining, color, shading, or typography used to show relative quantity or importance of different screen items?	☑ o o	
7.22	Are borders used to identify meaningful groups?	☑ o o	

7.23	Has the same color been used to group related elements?	☑ ○ ○	
7.24	Is color coding consistent throughout the system?	☑ ○ ○	
7.25	Is color used in conjunction with some other redundant cue?	○ ○ ☑	
7.26	Is there good color and brightness contrast between image and background colors?	☑ ○ ○	
7.27	Have light, bright, saturated colors been used to emphasize data and have darker, duller, and desaturated colors been used to de-emphasize data?	☑ ○ ○	
7.28	Is the first word of each menu choice the most important?	○ ○ ☑	
7.29	Does the system provide *mapping:* that is, are the relationships between controls and actions apparent to the user?	○ ○ ☑	
7.30	Are input data codes distinctive?	○ ○ ☑	
7.31	Have frequently confused data pairs been eliminated whenever possible?	○ ○ ☑	
7.32	Have large strings of numbers or letters been broken into chunks?	○ ○ ☑	
7.33	Are inactive menu items grayed out or omitted?	○ ○ ☑	
7.34	Are there menu selection defaults?	○ ☑ ○	
7.35	If the system has many menu levels or complex menu levels, do users have access to an on-line spatial menu map?	○ ○ ☑	
7.36	Do GUI menus offer affordance: that is, make obvious where selection is possible?	☑ ○ ○	
7.37	Are there salient visual cues to identify the active window?	○ ○ ☑	
7.38	Are function keys arranged in logical groups?	○ ○ ☑	
7.39	Do data entry screens and dialog boxes indicate when fields are optional?	○ ○ ☑	
7.40	On data entry screens and dialog boxes, are dependent fields displayed only when necessary?	○ ○ ☑	

8. Fexibility and Minimalist Design

Accelerators-unseen by the novice user-may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. Provide alternative means of access and operation for users who differ from the "average" user (e.g., physical or cognitive ability, culture, language, etc.)

#	Review Checklist	Yes No N/A	Comments
8.1	If the system supports both novice and expert users, are multiple levels of error message detail available?	○ ☑ ○	
8.2	Does the system allow novices to use a keyword grammar and experts to use a positional grammar?	○ ☑ ○	
8.3	Can users define their own synonyms for commands?	○ ☑ ○	
8.4	Does the system allow novice users to enter the simplest, most common form of each command, and allow expert users to add parameters?	○ ☑ ○	
8.5	Do expert users have the option of entering multiple commands in a single string?	○ ☑ ○	
8.6	Does the system provide function keys for high-frequency commands?	○ ☑ ○	
8.7	For data entry screens with many fields or in which source documents may be incomplete, can users save a partially filled screen?	○ ☑ ○	
8.8	Does the system automatically enter leading zeros?	○ ☑ ○	
8.9	If menu lists are short (seven items or fewer), can users select an item by moving the cursor?	○ ○ ☑	
8.10	If the system uses a type-ahead strategy, do the menu items have mnemonic codes?	○ ☑ ○	
8.11	If the system uses a pointing device, do users have the option of either clicking on fields or using a keyboard shortcut?	○ ○ ☑	
8.12	Does the system offer "find next" and "find previous" shortcuts for database searches?	○ ☑ ○	
8.13	On data entry screens, do users have the option of either clicking directly on a field or using a keyboard shortcut?	○ ☑ ○	
8.14	On menus, do users have the option of either clicking directly on a menu item or using a keyboard shortcut?	○ ○ ☑	
8.15	In dialog boxes, do users have the option of either clicking directly on a dialog box option or using a keyboard shortcut?	○ ○ ☑	
8.16	Can expert users bypass nested dialog boxes with either type-ahead, user-defined macros, or keyboard shortcuts?	○ ○ ☑	

9. Aesthetic and Minimalist Design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

#	Review Checklist	Yes	No	N/A	Comments
9.1	Is only (and all) information essential to decision making displayed on the screen?	☑	☐	☐	
9.2	Are all icons in a set visually and conceptually distinct?	☑	☐	☐	
9.3	Have large objects, bold lines, and simple areas been used to distinguish icons?	☑	☐	☐	
9.4	Does each icon stand out from its background?	☑	☐	☐	
9.5	If the system uses a standard GUI interface where menu sequence has already been specified, do menus adhere to the specification whenever possible?	☐	☐	☑	
9.6	Are meaningful groups of items separated by white space?	☐	☑	☐	
9.7	Does each data entry screen have a short, simple, clear, distinctive title?	☑	☐	☐	
9.8	Are field labels brief, familiar, and descriptive?	☑	☐	☐	
9.9	Are prompts expressed in the affirmative, and do they use the active voice?	☐	☐	☑	
9.10	Is each lower-level menu choice associated with only one higher level menu?	☐	☐	☑	
9.11	Are menu titles brief, yet long enough to communicate?	☑	☐	☐	
9.12	Are there pop-up or pull-down menus within data entry fields that have many, but well-defined, entry options?	☐	☑	☐	

10. Help and Documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

#	Review Checklist	Yes	No	N/A	Comments
10.1	If users are working from hard copy, are the parts of the hard copy that go on-line marked?	☐	☐	☑	
10.2	Are on-line instructions visually distinct?	☐	☐	☑	
10.3	Do the instructions follow the sequence of user actions?	☑	☐	☐	
10.4	If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected?	☑	☐	☐	
10.5	Are data entry screens and dialog boxes supported by navigation and completion instructions?	☐	☐	☑	
10.6	If menu items are ambiguous, does the system provide additional explanatory information when an item is selected?	☑	☐	☐	
10.7	Are there memory aids for commands, either through on-line quick reference or prompting?	☐	☐	☑	
10.8	Is the help function visible; for example, a key labeled HELP or a special menu?	☑	☐	☐	
10.9	Is the help system interface (navigation, presentation, and conversation) consistent with the navigation, presentation, and conversation interfaces of the application it supports?	☑	☐	☐	
10.10	Navigation: Is information easy to find?	☑	☐	☐	
10.11	Presentation: Is the visual layout well designed?	☑	☐	☐	
10.12	Conversation: Is the information accurate, complete, and understandable?	☑	☐	☐	

#	Review Checklist	Yes	No	N/A	Comments
10.13	Is the information relevant?	☑	☐	☐	
10.14	Goal-oriented (What can I do with this program?)	☑	☐	☐	
10.15	Descriptive (What is this thing for?)	☑	☐	☐	
10.16	Procedural (How do I do this task?)	☑	☐	☐	
10.17	Interpretive (Why did that happen?)	☐	☑	☐	
10.18	Navigational (Where am I?)	☐	☑	☐	
10.19	Is there context-sensitive help?	☐	☑	☐	
10.20	Can the user change the level of detail available?	☐	☑	☐	
10.21	Can users easily switch between help and their work?	☐	☑	☐	
10.22	Is it easy to access and return from the help system?	☑	☐	☐	
10.23	Can users resume work where they left off after accessing help?	☑	☐	☐	

11. Skills

The system should support, extend, supplement, or enhance the user's skills, background knowledge, and expertise ----not replace them.

#	Review Checklist	Yes	No	N/A	Comments
11.1	Can users choose between iconic and text display of information?		✓		
11.2	Are window operations easy to learn and use?			✓	
11.3	If users are experts, usage is frequent, or the system has a slow response time, are there fewer screens (more information per screen)?		✓		
11.4	If users are novices, usage is infrequent, or the system has a fast response time, are there more screens (less information per screen)?		✓		
11.5	Does the system automatically color-code items, with little or no user effort?	✓			
11.6	If the system supports both novice and expert users, are multiple levels of detail available.		✓		
11.7	Are users the initiators of actions rather than the responders?			✓	
11.8	Does the system perform data translations for users?	✓			
11.9	Do field values avoid mixing alpha and numeric characters whenever possible?		✓		
11.10	If the system has deep (multilevel) menus, do users have the option of typing ahead?		✓		
11.12	When the user enters a screen or dialog box, is the cursor already positioned in the field users are most likely to need?		✓		
11.13	Can users move forward and backward within a field?	✓			
11.14	Is the method for moving the cursor to the next or previous field both simple and visible?	✓			
11.15	Has auto-tabbing been avoided except when fields have fixed lengths or users are experienced?		✓		
11.16	Do the selected input device(s) match user capabilities?			✓	
11.17	Are cursor keys arranged in either an inverted T (best for experts) or a cross configuration (best for novices)?			✓	
11.18	Are important keys (for example, ENTER , TAB) larger than other keys?			✓	
11.19	Are there enough function keys to support functionality, but not so many that scanning and finding are difficult?			✓	
11.20	Are function keys reserved for generic, high-frequency, important functions?			✓	
11.21	Are function key assignments consistent across screens, subsystems, and related products?			✓	
11.22	Does the system correctly anticipate and prompt for the user's probable next activity?		✓		

12. Pleasurable and Respectful Interaction with the User

The user's interactions with the system should enhance the quality of her or his work-life. The user should be treated with respect. The design should be aesthetically pleasing- with artistic as well as functional value.

#	Review Checklist	Yes	No	N/A	Comments
12.1	Is each individual icon a harmonious member of a family of icons?	✓			
12.2	Has excessive detail in icon design been avoided?	✓			
12.3	Has color been used with discretion?		✓		
12.4	Has the amount of required window housekeeping been kept to a minimum?			✓	
12.5	If users are working from hard copy, does the screen layout match the paper form?			✓	
12.6	Has color been used specifically to draw attention, communicate organization, indicate status changes, and establish relationships?	✓			
12.7	Can users turn off automatic color coding if necessary?		✓		
12.8	Are typing requirements minimal for question and answer interfaces?	✓			
12.9	Do the selected input device(s) match environmental constraints?			✓	
12.13	If the system uses multiple input devices, has hand and eye movement between input devices been minimized?			✓	
12.14	If the system supports graphical tasks, has an alternative pointing device been provided?			✓	

12.15	Is the numeric keypad located to the right of the alpha key area?	O O ✓	
12.16	Are the most frequently used function keys in the most accessible positions?	O O ✓	
12.17	Does the system complete unambiguous partial input on a data entry field?	O O ✓	

13. Privacy

The system should help the user to protect personal or private information- belonging to the user or the his/her clients.

#	Review Checklist	Yes No N/A	Comments
13.1	Are protected areas completely inaccessible?	O O ✓	
13.2	Can protected or confidential areas be accessed with certain passwords.	O O ✓	
13.3	Is this feature effective and successful.	O O ✓	

B.6 PHQ-9 questionnaire

Over the last two weeks, how often have you been bothered by any of the following problems?

1. Little interest or pleasure in doing things?

2. Feeling down, depressed, or hopeless?

3. Trouble falling or staying asleep, or sleeping too much?

4. Feeling tired or having little energy?

5. Poor appetite or overeating?

6. Feeling bad about yourself - or that you are a failure or have let yourself or your family down?

7. Trouble concentrating on things, such as reading the newspaper or watching television?

8. Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual?

9. Thoughts that you would be better off dead, or of hurting yourself in some way?

B.7 Rosenberg self-steem questionnaire

1. On the whole, I am satisfied with myself.

2. At times I think I am no good at all.

3. I feel that I have a number of good qualities.

4. I am able to do things as well as most other people.

5. I feel I do not have much to be proud of.

6. I certainly feel useless at times.

7. I feel that I'm a person of worth, at least on an equal plane with others.

8. I wish I could have more respect for myself.

9. All in all, I am inclined to feel that I am a failure.

10. I take a positive attitude toward myself.

B.8 EAT-26 questionnaire

1. Am terrified about being overweight.2. Avoid eating when I am hungry.

3. Find myself preoccupied with food.

4. Have gone on eating binges where I feel that.

I may not be able to stop.

5. Cut my food into small pieces.

6. Aware of the calorie content of foods that I eat.

7. Particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes, etc.)

8. Feel that others would prefer if I ate more.

9. Vomit after I have eaten.

10. Feel extremely guilty after eating.

11. Am preoccupied with a desire to be thinner.

12. Think about burning up calories when I exercise.

13. Other people think that I am too thin.

14. Am preoccupied with the thought of having fat on my body.

15. Take longer than others to eat my meals.

16. Avoid foods with sugar in them.

17. Eat diet foods.

18. Feel that food controls my life.

19. Display self-control around food.

20. Feel that others pressure me to eat.

21. Give too much time and thought to food.

22. Feel uncomfortable after eating sweets.

23. Engage in dieting behavior.

24. Like my stomach to be empty.

25. Have the impulse to vomit after meals.

26. Enjoy trying new rich foods.

B.9 CAGE questionnaire

1. Have you ever felt you needed to **C**ut down on your drinking?

2. Have people **A**nnoyed you by criticizing your drinking?

3. Have you ever felt **G**uilty about drinking?

4. Have you ever felt you needed a drink first thing in the morning (**E**ye-opener) to steady your nerves or to get rid of a hangover?

B.10 WHO-5 questionnaire

Please respond to each item regarding how you felt in the last two weeks.

1. I have felt cheerful in good spirits.

2. I have felt calm and relaxed.

3. I have felt active and vigorous.

4. I woke up feeling fresh and rested.

5. My daily life has been filled with things that interest me.

B.11 PHQ-15 questionnaire

1. Over the last week, how often have you been bothered by stomach pain?

2. Over the last week, how often have you been bothered by back pain?

3. Over the last week, how often have you been bothered by pain in your arms, legs or joints (knees, hips, etc.)?

4. Over the last week, how often have you been bothered by menstrual cramps or other problems with your periods?

5. Over the last week, how often have you been bothered by headaches?

6. Over the last week, how often have you been bothered by dizziness?

7. Over the last week, how often have you been bothered by feeling your heart pound or race?

8. Over the last week, how often have you been bothered by shortness of breath?

9. Over the last week, how often have you been bothered by pain or problems during sexual intercourse?

10. Over the last week, how often have you been bothered by constipation, loose bowels or diarrhea?

11. Over the last week, how often have you been bothered by nausea, gas or indigestion?

12. Over the last week, how often have you been bothered by feeling tired or having low energy?

13. Over the last week, how often have you been bothered by trouble sleeping?
14. Over the last week, how often have you been bothered by chest pain?
15. Over the last week, how often have you been bothered by fainting spells?