Politecnico di Torino

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Design and implementation of a Mobile-based monitoring and recommendation system for healthy lifestyle habits

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Abstract

The average age in Italy is on the rise, reflecting not only better living conditions but also a mentality shift towards more active and healthier lifestyles. Yet, a sedentary lifestyle remains prevalent, particularly in the post-Covid era, highlighting the need for active measures to encourage active and healthy routines. The Health App project, a collaboration between Azienda Ospedale di Verona, the University of Sydney, and Dipartimento di Automatica e Informatica (DAUIN) at Politecnico di Torino, seeks to address this challenge. By harnessing vast data sources and applying Persuasive Design Principles, the project aims to create a user-friendly mobile application that serves as a central hub for easy data access and guidance, ultimately supporting users in achieving their lifestyle goals.

The app's development began with an extensive evaluation of existing applications, focusing on identifying key features prevalent in similar health-oriented apps. This process was guided by H. Oinas-Kukkonen and M. Harjumaa's design principles, with the aim of improving lifestyle changes through the app's features. From this foundation, both functional and non-functional requirements were defined for the application. The design phase involved building various diagrams, including Architecture Diagrams, to define the app’s structure. Flutter was chosen as the development framework due to its straightforward learning curve and robust support from Google, ensuring seamless integration with data sources like Google Fit and Fitbit. The application features over 12 customized data visualizations, created with Flutter packages such as fl_charts, to present information engagingly and intuitively. Additionally, an educational module comprising lessons and quizzes was introduced to enhance users' knowledge about lifestyle changes.

Key Words:

Persuasive Design Principles, Health Monitoring, Mobile Application, Lifestyle Change, Flutter Framework, User Engagement, Data Visualization, Behavioral Modification.

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1. Introduction

1.1. Problem Description

While various health monitoring applications are available, many do not provide curated, ongoing support to empower long-term behavior change. Personalized guidance and simple tracking interfaces can get lost amid large libraries of fitness tools. This project aims to address such gaps by developing an intuitive mobile application designed to make health tracking engaging and straightforward for users through tailored guidance over time-based on individual needs and goals.

Technology has increasingly influenced lifestyles and behaviors. Digital tools intentionally designed using these principles can generate either positive or negative changes (Fogg, 2003, #). Applications that provide personalized, evidence-based guidance and timely tracking reminders allow users to develop beneficial habits long-term (Oinas-Kukkonen et al., 2008, #). However, platforms prioritizing repetitive engagement over usability and utility could enable issues like addiction. The outcomes depend on design and user interaction - interfaces empowering tracking to enhance lifestyle versus those prioritizing engagement potentially at the cost of well-being over time. With prudent development and use, technology offers opportunities to advance traditional health models in ways that benefit users.

In this collaborative project between the University Hospital of Verona and the University of Sydney, different methods of engagement, like gamification, reminders, and personalized reviews are used as key strategies to create long-lasting health habits among a wide-ranging adult demographic, typically those advancing beyond their middle years. The integration of responsive monitoring and personalized exchanges aims to create continuous engagement by making health monitoring an interactive and enjoyable experience, thereby supporting the transition from light-hearted efforts to enduring lifestyle changes.

In essence, the challenge revolves around harnessing the potential of technology to actively engage individuals and direct these interactions towards enhancing their lifestyle choices. Achieving this objective needs examination of existing tools, their unique attributes and dimensions, as well as an in-depth understanding of the behaviors and capabilities of the individuals under study.

1.2. Objectives

1.2.1. General Objective

Design and develop a mobile application leveraging the Flutter framework that empowers individuals with devices capable of tracking health measures to establish and sustain healthier lifestyle choices.

1.2.2. Specific Objectives

- Analyze features and characteristics of possible complementary or alternative services based on pre established frameworks for habit development applications.
- Recognize the required data, its relationships, characteristics, and sources, to establish the required databases and data consumption systems.
- Establish the architecture and components of the system based on previously leveraged requirements and user cases, using well-defined documentation.
- Design non-functional mockups of the application that showcases the structure and the visually appealing features of the application.
- Develop a prototype of a mobile app using the Flutter Framework, based on the guidelines of the recognized requirements, data models, and architecture previously established.

1.3. Frame of Reference

1.3.1. Precedents

The project's goal is to achieve the adoption and regular development of healthy habits, positioning the app as a digital coach and guide. This involves defining and integrating technological guidelines for behavioral modification into the app's framework, to encourage both initial and ongoing user engagement. Being guided by established behavioral theories, these guidelines will shape the app's support for educational, nutritional, physical, and sleep-related habits, aiding users in achieving their wellness goals. Emphasis will be placed on

employing interactive and personalized techniques to captivate and maintain user interest over time.

In software development, requirement engineering is crucial for defining what a computer-based system must do (functional requirements) and how it should perform (non-functional requirements) (Sommerville & Sawyer, 1997, #). The document *A Systematic Framework for Designing and Evaluating Persuasive Systems* by H. Oinas-Kukkonen and M. Harjumaa provides a framework for persuasive software, categorizing features into Primary Task Support ("The design principles in this category support the carrying out of the user's primary task."), System Credibility ("The design principles in the system credibility category describe how to design a system so that it is more credible and thus more persuasive."), Dialogue Support ("The design principles related for implementing computer-human dialogue support in such a manner that helps users keep moving towards their goal or target behavior."), and Social Support ("The design principles in the social support category describe how to design the system so that it motivates users by leveraging social influence."). These categories inform the design of features that encourage users to form healthy routines, integrating into the system's requirements.

Many apps and services successfully use the PSD (Persuasion Context) model, which outlines principles and strategies for Persuasive Design. This model focuses on three main elements: "Intent" refers to the system's purpose to change behavior or attitude, "Event" involves the specific circumstances or interactions triggering persuasive elements, and "Strategy" is the approach or methods used to achieve the intended persuasive outcome (Torning & Oinas-Kukkonen, 2009, #).
Examples of applications in which the PSD model has been implemented, in their goal and features, are:

- Duolingo: (*Duolingo: Language Lessons - Apps on Google Play*, 2024) Uses personalized learning paths and social sharing features, aligning with the PSD model's emphasis on tailoring content and leveraging social influence.
- Fitbit and Google Fit: (*Google Fit: Activity Tracking - Apps on Google Play*, 2024) Utilize self-monitoring and goal-setting, key aspects of the PSD model, to motivate users towards healthier habits.

- MyFitnessPal: (*MyFitnessPal: Cuenta Calorías - Apps En Google Play*, 2024) This app assists users in tracking their dietary intake and exercise, employing self-monitoring, goal-setting, and feedback to motivate healthy eating and physical activity habits.
- Headspace: (*Headspace: Sleep & Meditation - Apps on Google Play*, 2024) A meditation and mindfulness app that uses personalized sessions, reminders, and progress tracking to encourage regular meditation practice, enhancing mental well-being.

1.3.2. Theoretical Framework

The categories and principles defined by Oinas-Kukkonen and Harjumaa, establish a guide for the design of systems that effectively change user behaviors or attitudes. Each category focuses on different aspects of interaction and persuasion. These are the principles contained in the previously described categories:

- Primary Task Support:
    - Reduction: Simplifies complex behaviors into manageable tasks.
    - Tunneling: Guides users through a persuasive process.
    - Tailoring: Customizes information to user-specific needs and contexts.
    - Personalization: Provides content or services tailored to the individual.
    - Self-monitoring: Enables users to track their performance or status.
    - Simulation: Allows users to see the consequences of their actions.
    - Rehearsal: Offers practice opportunities for behavior modification.
- Dialogue Support:
    - Praise: Uses positive feedback to enhance openness to persuasion.
    - Rewards: Motivates through incentives for target behaviors.
    - Reminders: Keeps users focused on their behavioral goals.
    - Suggestion: Provide timely advice to encourage desired actions.
    - Similarity: Uses relatable elements to increase persuasiveness.
    - Liking: Attracts users with a visually appealing design.
    - Social Role: Engages users by adopting a relatable persona.
- System Credibility Support:
    - Trustworthiness: Builds confidence through honesty and fairness.
    - Expertise: Demonstrates knowledge and competence.

    - Surface Credibility: Relies on first impressions for credibility.
    - Real-world Feel: Shows the real people or organizations behind the content.
    - Authority: Utilizes authoritative roles to enhance persuasion.
    - Third-party Endorsements: Leverages reputable sources to boost credibility.
    - Verifiability: Allows users to confirm information through external sources.
- Social Support:
    - Social Learning: Encourages behavior by observing others.
    - Social Comparison: Motivates through peer performance comparison.
    - Normative Influence: Applies social pressure for behavior adoption.
    - Social Facilitation: Shows that others are also engaging in the behavior.
    - Cooperation: Drives behavior change through collaborative efforts.
    - Competition: Stimulates action through competitive elements.
    - Recognition: Offers public acknowledgment for achievements.

(Oinas-Kukkonen et al., 2008, #)

The project aims to achieve meaningful and sustained modification in the user's routines. The transtheoretical model sustains that changes in behavior take three steps: pre-contemplation (Not ready to change soon), contemplation (Planning to change soon), preparation (Ready to act soon), action (Recently started change), maintenance (Continues behavior over time), and termination (No desire to return to old behaviors). To achieve change, a stage-matched intervention is required. It also establishes that computer-based, personalized, and interactive interventions improve results, both actively and passively (Porchaska & Velicer, 1997, #). B.J. Fogg's behavior model suggests that for a behavior to happen, three elements must align: Motivation, Ability, and Prompt. Essentially, the easier a task is to do (requiring less ability), the less motivation is needed to perform it, and vice versa for challenging tasks. This model highlights the balance between a task's difficulty and the required motivation to engage in it consistently (*Fogg Behavior Model | Behavior Design Lab*, 2024). Both models emphasize the importance of tailored approaches to behavior change, highlighting the need for interventions that consider an individual's readiness and capacity for change. This aligns with the project's goal of obtaining sustained habit modification, as these models can be used to design interventions that are both approachable and engaging, making sure they fit with users at various stages of their lifestyle change.

2. Methodology

2.1. Analyze and Select Features

To define the methodology for determining the desired functionalities of the system, we'll employ H. Oinas-Kukkonen and M. Harjumaa's behavioral change system design principles. The approach involves two main steps: initially, we'll identify and describe how each principle is implemented in a set of apps. Afterward, we'll focus on the recurrent apps that successfully incorporate these principles, their characteristics, and any principles that they might implement. This will enable us to pinpoint the most commonly utilized principles for potential inclusion in our app's design.

2.2. Define Functional and Non-functional Requirements

The step of Requirements Engineering involves systematically gathering, specifying, and analyzing what the system should do (functional requirements) and how it should perform (non-functional requirements such as performance, usability, reliability, etc.). For both types of requirements a table that identifies, names, and describes each one will be built. In the case of non-functional requirements, it will also identify to which functional one it applies. The goal is to be very detailed on the function, as these are the parts and services of the developed app.

2.3. Visual Design and Mockup Development

In this phase of the methodology, it will be aimed to pass from the theoretical framework and functional requirements into concrete visual designs. This process involves analyzing existing successful applications to identify and extract effective UI/UX design elements that adhere to H. Oinas-Kukkonen and M. Harjumaa's behavioral change system design principles. Following this, sketching preliminary hand-drawn mockups of key application screens, integrating insights from our analysis to ensure the designs are user-centric, engaging, and conducive to promoting healthy behavioral changes. These drawings follow multiple meetings to achieve the desired object to materialize. The final outcome of this

phase is a set of detailed digital mockups, complete with interaction design specifications, ready for the next stage of prototype development, ensuring a seamless bridge between our app's envisioned functionality and its practical, user-friendly implementation.

2.4. Implement a prototype for the mobile app

The initial step involves selecting the appropriate technologies for the app, focusing on database systems and the development framework. Flutter 3.10 is a suitable choice for the framework, complemented by Fire Store for database and authentication services. Setting up a conducive development environment is crucial, with Visual Studio Code and necessary mobile development extensions being recommended. Flutter's official documentation provides detailed setup instructions, accessible online.

https://docs.flutter.dev/get-started/editor

Adopting an iterative approach will make the development faster, focusing on delivering a functional minimally viable product. Features will be developed and validated individually, prioritizing functionality over design for immediate usability.

3. Presentation of Results

3.1. Competitors Study

To start the application's design, multiple similar, complementary, or related programs were selected from Google's applications marketplace 'PlayStore', they were picked from the top lists about lifestyle, education, and health, based on the number of downloads and rates received.

ID	Name	Rating	Number of downloads	Goal
1	Duolingo	4.6/5	100 M	Learn Languages
2	Forest	4.6/5	10 M	Focus on tasks
3	Zepp Life	3.8/5	100 M	Follow Exercises and fitness devices
4	Alarmy	4.6/5	10 M	Help waking up
5	Fitbit	3.5/5	50 M	Help user follow a healthier lifestyle
6	Pokemon Sleep	3.4/5	1 M	Follow your sleep cycles and play
7	WeWard	4.4/5	5 M	Walk and get rewards
8	Google Fit	3.6/5	100 M	Reach health goals
9	Lifesum	4.5/5	10 M	Calories count, diet, healthy food
10	WinWalk	4.1/5	1 M	Pedometer and win rewards
11	FatSecret	4.7/5	50 M	Count calories and control diet

Table 1: Table of selected apps to analyzeTable 16

The list defined in Table 1 includes application in the areas of education, creating habits, helping at studies, games, exercise, and training. These programs are key references in the goal of creating and maintaining habits. Some more information about them:

1. Duolingo: It offers courses on music, math, and over 40 languages (*The Complete List of EVERY Duolingo Language in 2023*, 2023), it system leverages different methods to intervene in the users lifestyle, such as constant reminders, integration with social media, and a diverse tools for learning a language, which has proved Duolingo to be and effective strategy for learning vocabulary (*Gamification in Mobile-Assisted Language Learning: A Systematic Review of Duolingo Literature From Public Release of 2012 to Early 2020*, 2023). Duolingo as a program is closer to a game, which includes levels, badges, friends and rewards; rather than a traditional book to learn a language.
2. Forest: With the motto "Stay focused, be present", is an app designed to improve productivity. The goal of this app is to cultivate trees that are beautiful visual representations of tasks (Gallucci, 2019) that are taken care of over a period of time. Longer and more complicated work results in more beautiful plants, and breaking concentration results in dead trees, making your forest look uglier. The key to the impact of this app is, again, the gamification inserted in its system, with a forest working as a visual reminder of your results.
3. Zepp Life: The Amazfit application to be used by default with their wearable devices for health monitoring and support. It offers data visualization for multiple health measures, like steps, sleep, burned calories, blood pressure, and many others. It is a complementary system to the wearable devices rather than its own application.
4. Alarmy: This application is an alarm clock also known as "Sleep If U Can", referencing the feature of not stopping to ring until the user is physically out of bed or at least awake (Gilbert, 2012). Its goal is to influence a person's waking up habits by offering personalizable alarm systems with different 'challenges' to pass until the alarm stops. It also incorporates an information panel with statistics about the users morning habits, like hour of waking up and how much time from the start of the alarm did it take them to finish the challenge.
5. Fitbit: Serving as the default app for Fitbit's range of fitness trackers, this platform acts as an interface for personal health. It provides users with information and data on their physical activities, such as step count, heart rate, sleep patterns, and more. Fitbit encourages a healthier lifestyle by setting goals, tracking progress, and offering motivational challenges (*APP FITBIT*, 2024). The app also includes nutritional tracking, allowing users to log their food intake and monitor their calorie balance throughout the day. With Fitbit, users can connect with friends, compete in fitness

challenges, and share their achievements, which adds a social and competitive element to the experience.

6. Pokèmon Sleep: This app is designed to turn sleep into a game. By tracking the user's sleep patterns, the app encourages better sleep habits through the game of Pokemon. As users sleep, they interact with various Creatures in a gameplay environment that rewards good sleep routines with in-game progress (Lum, 2019, 1). The concept is to make improving sleep as enjoyable as catching and training Pokemon, addressing the benefits of rest for the player. By gamifying sleep, Pokemon Sleep offers a fun approach to improving the quality of one's sleep.
7. WeWard: Designed to promote physical activity by rewarding users for walking. The more you walk, the more 'wards' (In-app points) you earn, which can be exchanged for various rewards, such as discounts, products, or even cash. The app uses your phone's pedometer to track your steps, encouraging you to walk more often. WeWard's gamification makes the users stay active, transforming walking into a rewarding experience. With its user-friendly interface and a goal-oriented reward system, it supports users in achieving their fitness goals, and also contributes to overall well-being by encouraging movement as a part of a healthier lifestyle.
8. Google Fit: Google Fit collaborates with the World Health Organization and the American Heart Association (*Google Just Launched Heart Points. Here Are 5 Things You Need to Know.*, 2018) to provide users with science-backed advice and activity goals, like "Heart Points," to help improve health. By monitoring workouts, heart rate, and steps, the app aims to make it easier for users to understand their fitness levels and progress (Google, 2024). It also tracks different types of physical activities, such as running, biking, and walking, and integrates with other fitness apps to centralize all health data in one place. The app is designed to be accessible and useful to everyone, regardless of fitness level, and encourages users to increase their physical activity in a simple and measurable way.
9. Lifesum: This app is a digital self-care tool that assists users in creating healthier eating habits, losing weight, and improving their overall fitness. By tracking meals and logging food intake, Lifesum calculates and provides feedback on the nutritional value of users' diets. It offers personalized meal plans, recipes tailored to individual health goals, and macro tracking to ensure balanced nutrition. The app also includes a barcode scanner to easily obtain nutritional information from packaged foods.

10. FatSecret: It provides users with a platform for tracking their caloric intake and exercise, supporting their weight management goals. With a huge database of foods, including generic, brand-name, and restaurant items, users can easily log what they eat and monitor their nutritional intake. FatSecret features a calorie counter, a nutrition diary, a weight chart, and a journal to record personal experiences and milestones. Additionally, the app encourages community engagement through shared recipes and success stories, fostering a supportive environment for users.

3.2. Features Definition

3.2.1. Features Selection

For the analysis and selection of features, the previously eleven selected apps were used as benchmarks, each evaluated through H. Oinas-Kukkonen and M. Harjumaa's persuasive design principles. The principles associated with each feature category were outlined in the following tables. Through the use of these applications, we pinpointed the implementation of various features, identifying those that were consistently present across multiple platforms. This comprehensive evaluation led to the selection of the most prevalent features, ensuring our app's design is grounded in proven persuasive strategies and aligns with industry standards. The names of the apps were omitted and substituted for the Id used on Table 1.

Primary Task Support												
Reduction	x	x		x					x		x	45.45%
Tunneling	x	x		x	x	x		x	x		x	72.73%
Tailoring									x		x	18.18%
Personalization	x										x	18.18%
Self-monitoring	x	x	x	x	x	x	x	x	x	x	x	100.00%
Simulation												0.00%
Rehearsal	x											9.09%
App Id	1	2	3	4	5	6	7	8	9	10	11	

Table 2: Table 2: Table of primary tasks by App

For the Primary Task Support we saw an absolute prevalence of Self-monitoring, identified as a minimal feature for any app that attempts to modify the behavior of a user. Followed by Tunneling, as a way to guide a user to attempt to hit their goals.

Dialogue Support

Praise	x					x						18.18%
Rewards	x	x				x	x			x		45.45%
Reminders	x			x		x	x		x	x	x	63.64%
Suggestion		x	x	x		x	x	x	x		x	72.73%
Similarity												0.00%
Liking	x	x		x	x	x		x	x	x		72.73%
Social Role	x		x		x	x	x			x	x	63.64%
App Id	1	2	3	4	5	6	7	8	9	10	11	

Table 3: Table 3: Dialogue Support by app

Dialogue Support features, such as Liking and Suggestion, are prevalent across many applications, though not universally adopted. These features, particularly notable for their contribution to engaging design and seamless integration into user lifestyles, play a crucial role in fostering a positive user experience. Their presence encourages users to repeatedly engage with the app, enhancing its overall effectiveness in user retention.

System Credibility Support												
Trustworthiness								x	x			18.18%
Expertise					x							9.09%
Surface-credibility	x	x			x	x		x	x			54.55%
Real-world feel	x				x				x		x	36.36%
Authority					x							9.09%
Third-party endorsements								x				9.09%
Verifiabilit	x								x			18.18%

y												
App Id	1	2	3	4	5	6	7	8	9	10	11	

Table 4: Table 4: System Credibility by app

System Credibility presents a evident lower presence in the analyzed apps. The most relevant feature in the current feature is the Surface-Credibility. This shows that adding sources or experts intervention in the app's functionalities seems more as an extra feature rather than a key one to influence a user's behavior.

Social Support												
Social Learning	x											9.09%
Social Comparisn	x		x		x	x	x			x	x	63.64%
Normative Influence	x										x	18.18%
Social Facilitation											x	9.09%
Cooperatin						x						9.09%
Competitin	x					x	x			x		36.36%
Recognitin	x					x	x			x		36.36%
App Id	1	2	3	4	5	6	7	8	9	10	11	

Table 5: Table 5: Social Support by app

Lastly, the Social Support feature, in general, also presents a lower prevalence in the analyzed apps. The most common feature is the social comparison. It makes sense that not all types of programs require a social factor, also not all types of data should be shared.

Notably, Self-monitoring stands out as an essential component in Primary Task Support, underscoring its critical role in behavior modification efforts. Similarly, in Dialogue Support, features like Liking and Suggestion emerge as key to enhancing user engagement and app integration into daily routines. While System Credibility features like Surface-Credibility were

less prevalent, indicating a potential area for differentiation in our app. Social Support is the most notable aspect, Social Comparison, reflects selective use of social elements in app design. These findings will guide the next phase of the development, focusing on the in-depth examination of the most common features to define the app's design and functionality, aligning it with users' needs and persuasive technology principles.

3.2.2. Features Analysis

For the construction of the app and the definition of its content it will be helpful to have clear references and examples, with clear impact on the target users. Given the constraints on what can be correctly implemented, we'll prioritize features found in over 60% of the examined apps for further analysis. This approach ensures the creation of a minimal viable product that incorporates essential functionalities to our app's core service. On the other hand, less common features, while not immediately implementable within this project's scope, hold potential for distinguishing our app from competitors and will be considered for future development phases. Other apps beside the previously analyzed were used as reference as their implementation of some principles is more clear.

Tunneling	Couch to 5K	Guides users through a training program, gradually increasing running time and providing audio cues during workouts.
	Rosetta Stone	Guides language learners through lessons, focusing on one concept at a time and gradually introducing new vocabulary and grammar rules.
	MyFitnessPal	Guides users through calorie tracking by suggesting meals and providing nutritional information to reach fitness goals.
	Meditation & Relaxation: Guided Meditation	Guides users through meditation sessions, offering different relaxation techniques and durations.

Table 6: Tunneling implementation examples

Tunneling, as demonstrated in apps like Couch to 5K, Rosetta Stone, and MyFitnessPal, guides users through progressively challenging tasks, particularly in fitness and learning contexts. This step-by-step approach ensures a manageable increase in difficulty, fostering user adaptability and engagement. Incorporating the concept of Tunneling into our app, a virtual coach could be an possible implementation. This could take the form of either a real coach accessible through the app or a digital one, potentially supported by AI capabilities, to guide users through their health and fitness journeys with personalized, progressively challenging tasks.

Self-monitoring	WaterMinder	Provides insights into users' daily hydration habits by analyzing their water intake data. It offers visual charts and reports that show how consistently users meet their water intake goals and identifies patterns in their hydration behavior over time.
	Sleep Cycle	It offers detailed sleep analysis, including information about sleep phases and sleep quality, providing data for self-monitoring and improvement.
	Mint	Self-monitoring of finances is facilitated by categorizing transactions and providing customizable budget tracking tools. Users can track and analyze their spending habits, view reports, and identify areas where they can improve their financial management.

Table 7: Self-monitoring implementation examples

Self-monitoring, as exemplified by apps like WaterMinder, Sleep Cycle, and Mint, helps users in tracking and understanding their own behaviors in the change of their habits. These apps provide detailed analyses and visual representations, enabling users to monitor their progress towards personal goals and discern patterns over time. For our app, incorporating self-monitoring could involve features that allow users to track health-related metrics, supported by visual feedback and insights to encourage consistent engagement and self-improvement. This could be enhanced with personalized notifications or advice.

Reminders	Todoist	Todoist sends users task reminders and notifications to help them stay organized and on top of their to-do lists. Users receive reminders for upcoming tasks and deadlines.
	Google Calendar	Google Calendar sends event reminders to users, keeping them informed about upcoming appointments, meetings, and important dates.
	WaterMinder	WaterMinder reminds users to drink water at regular intervals throughout the day to maintain hydration. Users receive push notifications and reminders to meet their daily water intake goals.

Table 8: Reminders implementation examples

Reminders, as utilized by applications like Todoist, Google Calendar, and WaterMinder, play a crucial role in supporting users to stay organized and maintain healthy habits. These apps employ timely notifications and reminders to ensure users are aware of upcoming tasks, events, and habit-related actions, such as staying hydrated. Drawing from this, the proposed app could integrate reminder functionalities to prompt users to engage in health-promoting activities, reinforcing consistent habit formation.

Suggestion	Spotify	Spotify suggested playlists, songs, and artists based on a user's music preferences and listening history. Users receive personalized music recommendations to discover new tracks.
	Amazon	Amazon suggests products to users based on their browsing and purchase history, helping users discover relevant items and make

		informed buying decisions.
	Netflix	Netflix suggests movies and TV shows based on a user's viewing history and ratings. Users receive personalized recommendations for entertainment content.

Table 9: Suggestion implementation examples

Suggestion, as demonstrated by Spotify, Amazon, and Netflix, enhances user engagement by offering personalized recommendations based on individual preferences and historical interactions. These platforms adapt their suggestions to align with user's tastes in music, shopping habits, and entertainment choices, respectively. Similarly, integrating a suggestion feature in our app could provide users with customized health and wellness advice, drawing from their activity logs and health goals. This personalized approach aims to motivate users towards healthier habits, supported by tailored recommendations that resonate with their unique needs and preferences, potentially coupled with timely advice or notifications.

Liking	Pinterest	Pinterest's visually attractive design appeals to its users with a vast collection of pins and boards featuring various interests. Users can explore and save content that aligns with their preferences, fostering a sense of liking and engagement.
	Instagram	The app's layout and image-centric design make it visually attractive and engaging to users.
	Houzz	Houzz continues to provide a visually appealing experience with high-quality images of home designs and decor.

Table 10: Liking implementation examples

Liking, as illustrated by platforms like Pinterest, Instagram, and Houzz, is implemented through engaging and aesthetically pleasing designs. Pinterest entices users with its diverse

collections, Instagram with its image-focused layout, and Houzz with its quality home decor visuals. Drawing inspiration from this, the app could emphasize design appeal to boost user engagement, using attractive interfaces and content tailored to user's health and wellness. This design strategy aims to create a positive and inviting user experience, encouraging regular app usage and supporting users in their journey towards healthier lifestyle choices.

Social Role	Nextdoor	Nextdoor adopts a social role by connecting users with their local neighborhoods. Users can engage in discussions, share local news, and provide recommendations, creating a sense of community and a social role for the app.
	Meetup	Meetup serves as a platform for users to create and join interest-based groups and events. It encourages users to take on social roles by becoming event organizers or group leaders, facilitating social interactions and community building.
	Slack	Slack serves as a communication and collaboration tool for teams and workplaces. It plays a social role by enabling team members to engage in conversations, share files, and collaborate on projects within a virtual workspace.

Table 11: Social role implementation examples

Social Role in platforms like Nextdoor, Meetup, and Slack, involves the app acting as a facilitator for community and social interaction. Nextdoor connects users with local neighborhoods, fostering community engagement, while Meetup empowers users to organize and participate in interest-based groups, enhancing social connectivity. Slack, in a professional context, serves as a hub for team collaboration and communication. Integrating a Social Role feature into our app could involve creating a space for users to connect over shared health goals,

perhaps through group challenges or support forums, leveraging the app as a medium for community building and mutual support in achieving wellness objectives.

Social Comparison	Fitbod	Fitbod allows users to track their gym workouts and compare their performance in terms of weights, repetitions, and progress over time. Users can set personal records and view their achievements relative to previous workouts.
	MyPlate by Livestrong	MyPlate lets users log their daily meals and nutrition intake. The app includes a feature for users to compare their dietary choices with recommended daily allowances and make adjustments based on the comparison.
	MyFitnessPal	MyFitnessPal includes a "News Feed" where users can observe and interact with friends' fitness and nutrition progress. Users can compare their achievements and meal plans with others, fostering social comparison and motivation.

Table 12: Social Comparison implementation examples

Social Comparison, as seen in apps like Fitbod, MyPlate by Livestrong, and MyFitnessPal, leverages the power of comparison to motivate users. Fitbod enables workout tracking and performance comparison, MyPlate offers dietary tracking against recommended allowances, and MyFitnessPal's "News Feed" allows for viewing and interacting with friends' progress. Incorporating Social Comparison into our app could mean allowing users to share their health achievements against set standards or peer accomplishments, enhancing motivation through a community-driven approach to health and wellness goals.

3.2.3. Requirement Definition

In defining the mobile application's requirements, we adopted a comprehensive approach, identifying key functionalities from previously identified apps to ensure an all-inclusive user experience. This process generated a set of functional requirements encompassing user management, data analytics, reminders, and educational modules, to create an engaging and informative platform. Parallely, non-functional requirements were derived from industry standards, emphasizing portability, reliability, usability, and security, among others, to guarantee the app's performance and user satisfaction. These elements collectively establish the framework for a user-focused application designed to enhance health and wellness through digital means.

3.2.3.1. Functional requirements

FR1	**User Management**	
FR11	Login user	Allow a user to log in the app using different authentication methods
FR12	Logout user	Allow a user to log out of the app
FR13	Get Users information from more than one source	Return information about the user's profile
FR14	Register user	Give an option for users to register to use the app with their prefered credentials
FR15	User profile page	User's profile must display personal data, relevant to the current session
FR16	Password recovery	Implement a secure method for users to recover or reset their passwords.
FR17	Account deletion	Offer users the option to delete their account.

Table 13: Functional requirement - User Managment

The User Management functional requirements aim to establish a secure framework for user interactions within the app. The main goal is to facilitate easy access for personalized

experiences while ensuring user data protection and privacy. By implementing diverse authentication methods, clear login/logout processes, and multi-source user information retrieval, the app ensures accessibility and customization. Features like password recovery and account deletion emphasize user security and autonomy. Collectively, these functionalities will create a user-centric environment, enhancing engagement and trust in the app's ecosystem.

FR2	**Data Management**	
FR21	Data Availability	App has to source its data from different third party servers
FR22	Display steps	Display user's steps information, by day, by month, and week
FR23	Display calories spent	Display user's calories spent information, by day, by month, and week
FR24	Display sleep length	Display user's sleep length information, by day, by month, and week
FR25	Display calories intake	Display user's calories intake information, by day, by month, and week
FR26	Display stress rating	Display a quantitative rating of the user stress, by day, week, and month
FR27	Display Measurements	Users personal measurements, which include height, age, and weight, should be displayed on their user page
FR28	Date Selection	Implement a data selection option where users can jump from one date to any other, modifying the corresponding data
FR29	Date change	Users must be able to navigate from one date to the previous or next one with a single click

Table 14: Functional requirement - Data Management

The Data Management component of the application is designed with the goal of providing users with comprehensive insights into their health and fitness metrics. By taking data from various third-party servers, the app ensures a rich source of information, including minutes of

activity, calories burned, stress rates, sleep patterns, and dietary intake, all tailored to individual user profiles. This functionality not only facilitates a detailed view of daily, monthly, and weekly progress but also improves the user experience with features like date navigation and personalized data insights. Implementing these features aims to guide users with the knowledge and tools needed to make informed decisions about their health, encouraging a more active approach to wellness.

FR4	**Lessons and Tests management**	
FR41	Lessons storage	Informations about the lessons should be assigned to a users based on their past work
FR42	Lessons management	There must be a space to access and edit lessons for the system owners
FR43	Navigate lessons	Users should be able to navigate their lessons by different dates, get them assigned for each date.
FR44	Complete lessons	A way to identify is a lesson has be completed, that is, by finishing their corresponding lessons, should be added
FR45	Test storage	Informations about the test should be stored in relation to the test their correspond to
FR46	Test management	There must be a space to access and edit tests for the system owners
FR47	Navigate tests	Users should be able to navigate their tests by different dates, get them assigned for the corresponding assigned lesson.
FR48	Complete tests	A way to identify if a test has been completed, and therefore, completing the related lesson.

Table 16: Functional requirement -- Lessons and Tests management

The Lessons and Tests Management component is a key aspect of the application, designed to foster an educational and interactive environment for users. This feature facilitates personalized

learning experiences by assigning lessons and tests based on users past activities, ensuring content relevance and enhancing learning efficacy. System owners are given dedicated spaces for content management, allowing for the easy update and creation of educational materials. Users benefit from the flexibility to navigate through lessons and tests according to their schedules, with functionalities to track completion and progress. This structured approach not only supports user education in health and wellness but also encourages consistent engagement by marking milestones and achievements, thereby contributing to a learning journey.

These requirements are designed to ensure an easy to use, interactive, and personalized application that caters to the needs of the users. The focus will shift towards defining the non-functional requirements, which are essential for ensuring the application's reliability, usability, performance, and security. By establishing these criteria it is aimed to enhance the overall quality and user satisfaction, making the application not just functional but also highly efficient and secure. The functional requirements set the parameters for a user-centric platform, now, the detail of the non-functional specifications will ensure these elements complement and elevate the user experience.

3.2.3.2. Non-functional requirements

ID	**Type**	**Description**	**Refers To**
NFR1	Portability	The application must run at least on android phones	FR1, FR2, FR3, FR4
NFR2	Reliability	Achieve 99.9% correct functioning annually	FR1, FR2, FR3, FR4
NFR3	Usability	Most users should be able to use the application independent from age or training	FR1, FR2, FR3, FR4
NFR4	Security	The app must ensure secure login mechanisms and restrict access to sensitive user data to authorized users only	FR1, FR2, FR3, FR4
NFR5	Performance	The app should load content and respond to user inputs within 2 seconds under	FR1, FR2, FR3

		standard conditions, ensuring a smooth and responsive user experience.	
NFR6	Data Privacy	User data should comply with a client-only architecture and use OAUTH for data requests	FR1, FR2, FR3, FR4
NFR7	Interoperability	The application should integrate seamlessly with third-party services like Fitbit and Google Fit without user data discrepancies, to enhance functionality and data consistency.	FR2
NFR8	Maintainability	The codebase should be documented and structured to allow for easy updates and maintenance	FR1, FR2, FR3, FR4

Table 17: Non-functional requirements

The non-functional requirements for this application emphasize how it operates to ensure an optimal user experience and system performance. Portability ensures the app's accessibility across the main mobile platform, Android (statcounter, 2024), making it widely available to a diverse user base and ensuring consistent functionality across different devices. Reliability sets a high standard for correct operation, aiming for 99.9% correct functioning annually, which is crucial for maintaining user trust and minimizing disruptions. Usability focuses on creating an intuitive and accessible interface for users of all ages and technical backgrounds, which is key for user retention and satisfaction. Security prioritizes the protection of user data and ensures that sensitive information is accessible only to authorized personnel, addressing growing concerns about data breaches and privacy. Performance requires the app to be responsive, with content loading and interactive elements responding fast to user inputs, enhancing the overall user experience. Data Privacy sets high standards for data protection, employing client-only architecture and using OAuth for data requests to safeguard user information. Interoperability with third-party services like Fitbit and Google Fit enhances the app's functionality and data consistency, offering users a more integrated and comprehensive health tracking experience. Finally, Maintainability ensures that the app's codebase is well-documented and structured, facilitating easy updates and maintenance, which is essential for the app's long-term scalability

and adaptability. Together, these non-functional requirements are designed to ensure that the application is not only functional but also robust, secure, user-friendly, and sustainable over time.

3.3. Architecture Design

System architecture is the conceptual model that defines the structure, behavior, and more views of a system (Jaakkoррмшлинla & Thalheim, 2011, p.98). It is a blueprint that illustrates the organization of a system and the arrangement of its components, facilitating the understanding of how an application will work. The architecture diagram specifically visualizes the high-level structure of the software, providing a map of how each component of the application interfaces with each other, the flow of data, and how layers of the system are abstracted.

An architecture diagram typically outlines the major components or modules of the system, their responsibilities, and their interactions. It shows how the application is divided into layers, each with a specific role in the processing of information and user requests. This diagram acts as a guide for developers, offering a clear picture of the system's layout, aiding in development, troubleshooting, and maintenance efforts.

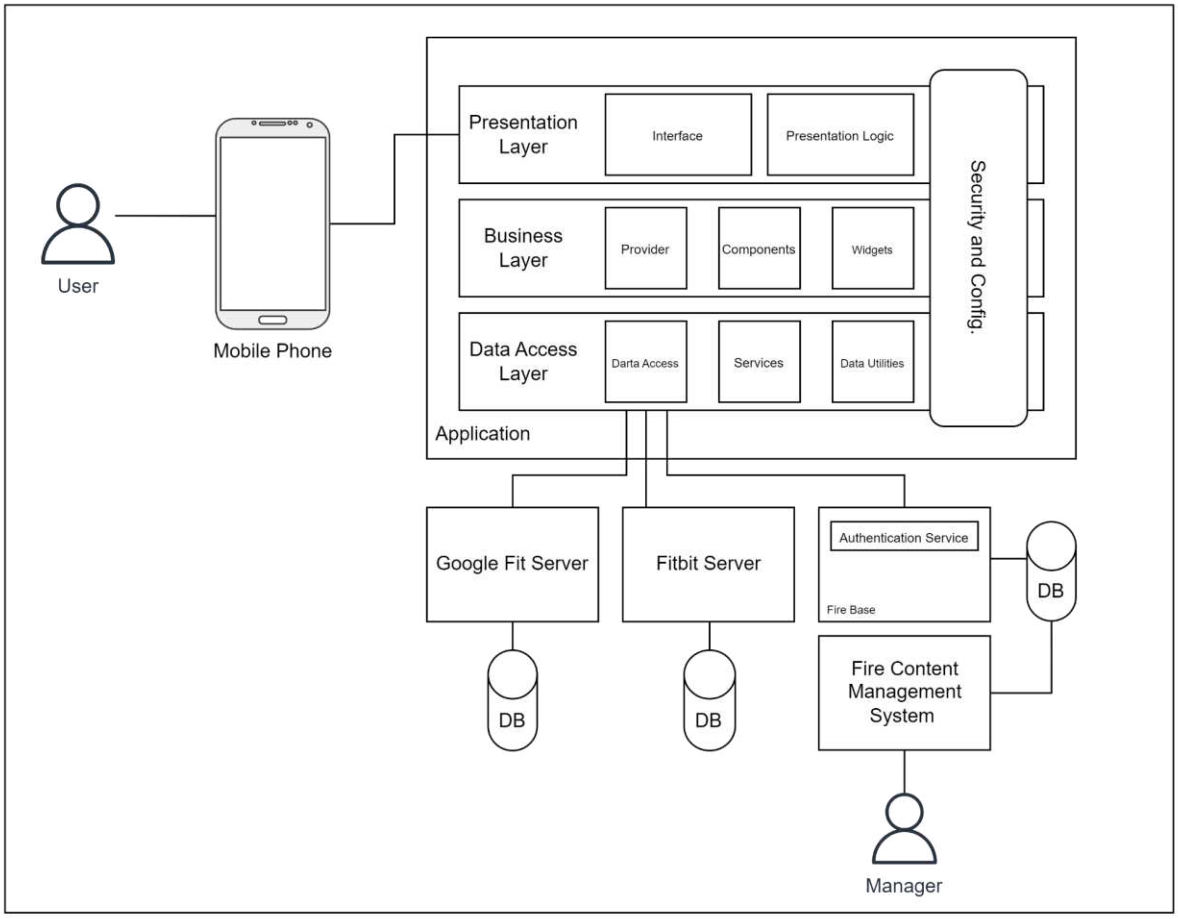


Figure 1: Architecture Diagram

Three core layers organize the application architecture:

- Presentation Layer: It comprises the Interface and Presentation Logic components. The Interface is what the user interacts with, encompassing the visual elements and navigation. The Presentation Logic orchestrates the display and response to user inputs, ensuring a seamless user experience.
- Business Layer: This is the heart of the application where the business logic resides. It consists of Providers that handle data retrieval and manipulation, Components that are the building blocks of the app's functionality, and Widgets that offer reusable UI elements.
- Data Access Layer: This layer handles all data interactions. It includes Data Access components that connect to databases or services to fetch and store data, Services that offer specific functionalities, and Data Utilities that perform common data operations.
- A vertical Security and Configuration layer spans across these three, integrating security measures and system configurations that protect data and ensure the app runs smoothly.

Externally, the application relies on services such as the Google Fit Server and Fitbit Server, each with its own database (DB), to fetch health-related data: Activity data from the first one, and stress related, sleep and food from the last. The app also integrates with Firebase, utilizing its Authentication Service for secure user sign-ins and its database for storing: User-related data, and lesson and quiz registers. Additionally, an external Content Management System for Firebase has been incorporated for easy definition and creation of lessons, that will be later stored on Firestore.

This architecture is carefully designed to ensure the app is secure, robust, and capable of providing a rich, interactive user experience while integrating with external health services for comprehensive health data management.

3.4. Application Design

The front-end design of an application is essentially the bridge between the user experience and the app's functionality. It encompasses the look and feel of the app, the user interface, and the overall navigational flow. This is crucial because it not only influences how users perceive the app but also determines how effectively they can interact with it. A good design can significantly enhance usability, ensuring that the app is not just functional but also enjoyable to use.

In this section of the thesis, it will be discussed the front-end design process for the application. It will feature a collection of initial drawings that illustrate the layout of the app’s pages, capturing the envisioned user experience. To complement the sketches, there will be photographs showcasing the chosen color palette and typographical styles, which have been selected to align with our app's intended user experience. These visual elements are paired with snapshots of other applications that have been sources of inspiration, demonstrating how established design patterns have influenced the taken approach. These components together will provide a comprehensive overview of the design groundwork that underpins the app’s development.

3.4.1. Design References

FatSecret, Google Fit, and Fitbit stand out as good models with their user interfaces that show clarity, aesthetic appeal, and fluidity. These applications have been selected due to their success in fostering an intuitive and comfortable user experience. Their design approaches facilitate effortless navigation and interaction, which are critical in an app that aims to promote health and wellness. The neat layouts, clear visual hierarchy, and responsive design elements contribute to an environment that encourages regular use. This section will explore how the salient features of these applications have informed our design decisions, from color schemes and typography to the overall user journey within the app.

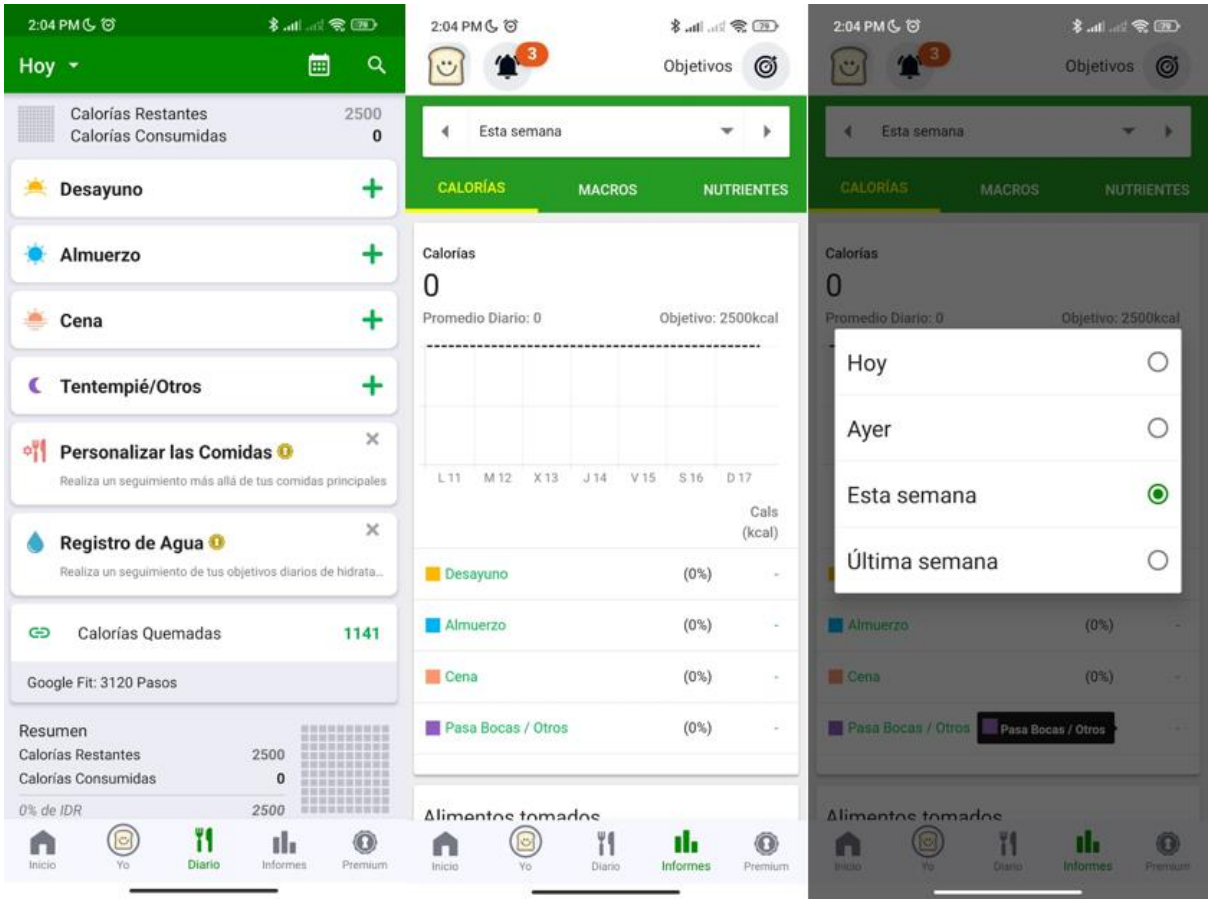


Figure 2: “FatSecret” pictures of pages

FatSecret's interface is a great reference point in the development of the application's design. The use of a distinct green color palette in FatSecret is both visually engaging and suggestive of health and vitality, qualities that align with the app's wellness goals. The presentation of the main data using card-based divisions allows for a clean and organized display of nutritional information, which is a design principle incorporated for its clarity and effectiveness.

Despite the strengths observed in FatSecret's layout, the extensive scrolling required to navigate through the dense information on the main page presents a potential issue for the user. In response, it would be prefered a design that presents a more modular approach to information delivery. The bar charts and customizable date range filters in FatSecret serve as good references of tools for data representation, providing users with the flexibility to view their health metrics over different periods. These features have inspired similar functionalities in this app but are implemented in a way that ensures data is accessible without overwhelming the user.

The inclusion of a bottom navigation bar and a top bar for immediate access to key features like notifications and objectives is another aspect drawn from FatSecret. This approach to global navigation helps to create an intuitive user experience through the app, which has been adapted to facilitate a smooth and logical flow for end-users. In summary, FatSecret has contributed significantly to the design choices, offering insights into creating an engaging yet straightforward user interface that promotes an enjoyable interaction with the application.

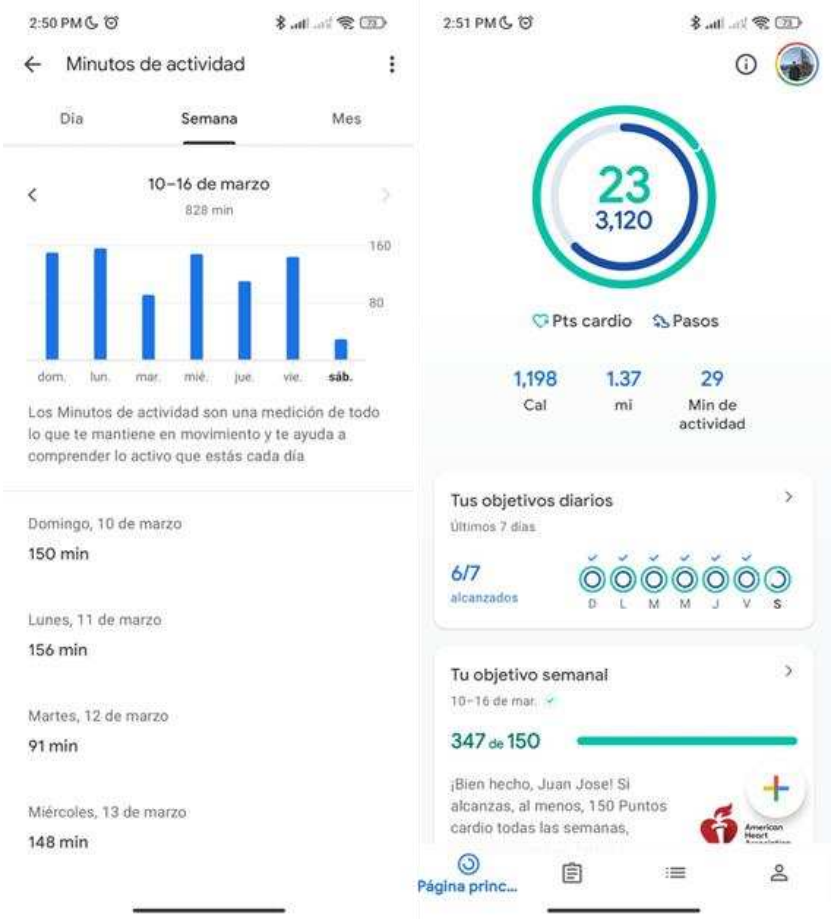


Figure 3: “Google Fit” Picture of pages

Google Fit's primary interface shows a prominent circular diagram, visually pleasing but lacking in immediate informational utility. This stylistic choice is followed by a numerical summary of key health metrics such as calorie burn, activity minutes, and distance traveled, a format that was found to be quite effective for quick user reference.

The app integrates a scrollable interface featuring cards that display daily goals and links to health information from reputable sources like the American Heart Association. While the scrollable nature of this layout could lead to user overload, the individual elements, such as goal tracking, are well-conceived.

In the second screenshot, a bar chart provides a weekly overview of activity minutes, with clear controls for navigating data over days, weeks, and months. The numeric display of activity durations under the chart also offers a clear way to read the data, which can be appreciated for its clarity.

The app's bottom navigation bar presents a clean structure to change through the app's features, an improvement over the more crowded approach seen in Fatsecret. Both the profile access points and the floating action button for manual data entry are useful for ease of use of the application. These aspects of Google Fit's design, the attention to navigational clarity, the integration of informative health resources, and the balance between aesthetics and functionality are good references for the current app.

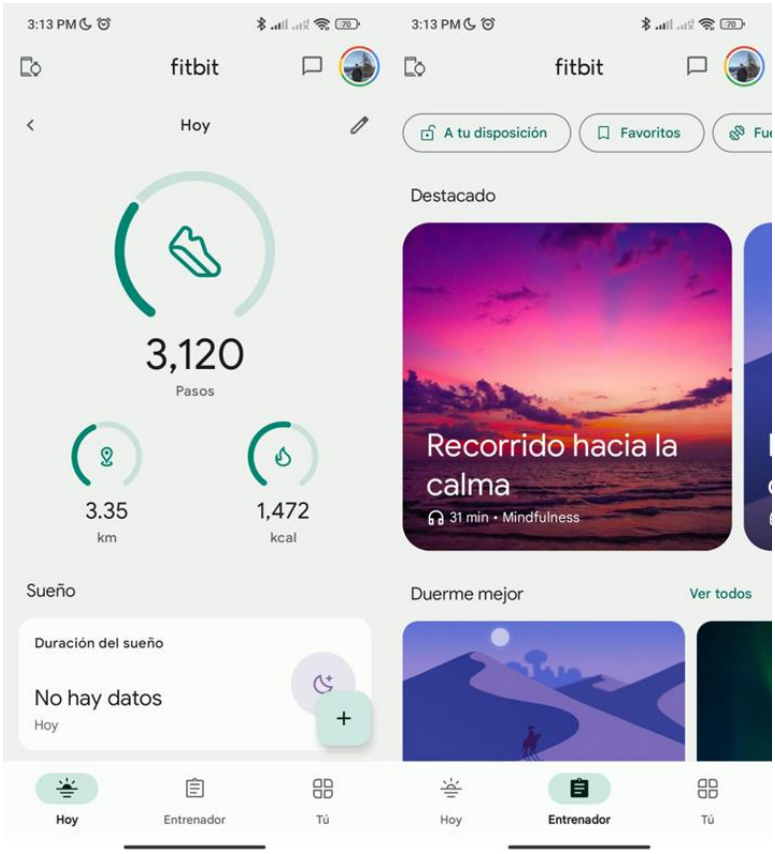


Figure 4: “Fitbit” pictures of pages

Similar to Google Fit, Fitbit features a main page with circular graphs representing steps, distance, and calories burned. The circles 'fill up' as users progress toward their goals, which works as a visual motivator. While the page offers a snapshot of daily achievements, the extensive scrolling required to access additional data is a noted downside. The app's adherence to a white background and minimalist aesthetic contributes to a clean interface, though it presents opportunities for better distinguishing between app sections.

A notable element is the presence of easily accessible controls for adding manual data entries and adjusting the date for displayed data. The bottom navigation bar has only three pages, it simplifies user movement within the app. In contrast, the 'Trainer' page introduces a dynamic component with guided sessions and sport activities displayed as a scrollable list of colorful cards, adding an energy to the user experience.

These design elements from Fitbit goal visualization, accessible data entry, and dynamic lesson presentation have informed aspects of this app’s design, ensuring that while it's aimed for a clean aesthetic, it's also prioritized navigational ease and engaging content presentation.

3.4.2. Color and Structure Design

```
const kGreen50 = Color(0xFFE0F7E0);
const kGreen100 = Color(0xFFC1F0C1);
const kGreen300 = Color(0xFF92E690);
const kGreen400 = Color.fromARGB(255, 45, 179, 52);

const kGreen900 = Color.fromARGB(255, 35, 102, 38);

const kErrorRed = Color(0xFFC5032B);

const kSurfaceWhite = Color(0xFFFFFBFA);
const kBackgroundWhite = Colors.white;

const kGreenShade = Color(0xFF388E3C);
```

Figure 5: Set of Colors of the theme

The chosen color palette plays an important role in defining the applications thematic and user interface.The design is based on a set of greens, symbolizing growth and well-being, with shades like kGreen50 providing a light backdrop and the richer kGreen900 accenting key interactive elements. Complementary colors like blue, for knowledge, red for physical activity, purple for stress, green for nutrition, and light blue for sleep create a categorization of the app's features. These choices not only make for a visually appealing interface but also aid in the cognitive association between color and function. The subsequent sections will showcase the practical application of this palette, illustrated through design drafts of the app's various pages.

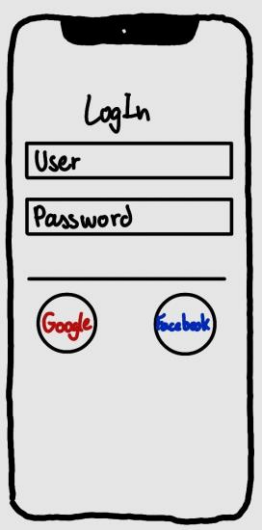


Figure 6: Drawing of the original login page

A series of hand-made drawings were created, serving as preliminary blueprints and helping as a common understanding among project collaborators. These sketches, illustrating the application's main features, were instrumental in visualizing the functional requirements defined earlier. They functioned as an original tool for discussions and alignment on the design approach. The sketches to be presented in this section focus on the main interface, login procedures, and the learning module, which form the core of the application. It's important to note that these illustrations represent an initial vision and are not definitive representations; they are flexible guides intended to guide the development process rather than fixed templates. Their role is to inform and shape the evolving design of the application as it progresses from concept to completion.

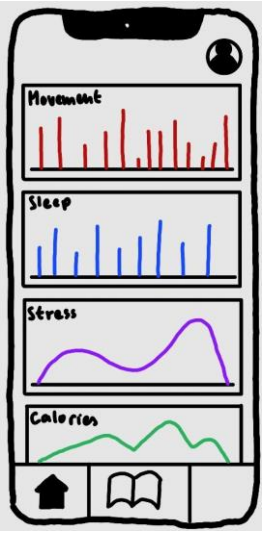


Figure 7: Drawing of the home page graphs

The initial screen design for the login page adopts a minimalist approach, prioritizing ease of use and clarity. The layout features fields for username and password entry, coupled with options for alternative authentication methods such as Google sign-in, facilitating accessibility and offering users the convenience of using existing accounts. The background will be a clean white, complemented input area, ensuring that the login process is as intuitive as possible.

The main page of the application is laid out for immediate access to health monitoring data. At the very top, a convenient button for users to navigate to their account details. Below, the screen is organized into a series of cards, each representing a different aspect of personal health metrics: movement, sleep, stress, and calorie intake. These cards feature color-coded graphs that not only add a visual appeal but also facilitate quick recognition of the different categories.

The time frame for these graphs is to be established during the developmental iterations, ensuring that the information displayed meets the users' needs and preferences effectively.

The bottom navigation bar anchors the user experience with clearly defined sections: the home dashboard, lessons, and an additional segment that's yet to be determined, potentially dedicated for values derived from the user's health data. This proposed layout is defined with the goal of making the app not only a tool for tracking but also a guide for health improvement, encouraging users to engage with the content actively.

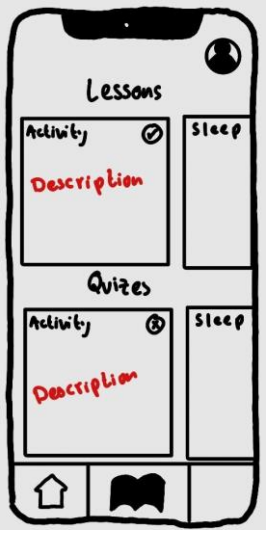


Figure 8: Drawing of the lessons and quizzes page

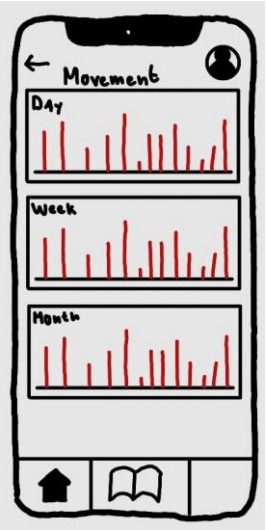
The lessons and quizzes page is designed to educate and engage users on their journey for better health habits. This page maintains the navigational consistency established throughout the app, with a bottom bar for transitions between sections. Displayed prominently are horizontally scrollable lists of lessons and quizzes, each offering information about different health-related topics such as activity and sleep.

Each lesson card provides a description and is marked with an indicator to show completion status, allowing users to track their progress. Following the lessons, users can take quizzes that correspond to the topics they've just learned. These quizzes serve as a tool for reinforcing

knowledge. The indicators on the quizzes offer immediate visual feedback, motivating users to continue their learning process using the app.

Figure 9: Drawing of the data in detail page

The sketch for the detailed activity graph page shows an expansion from the main page, offering users more information about their metrics over various timeframes, in this case the



drawing was made based on the measurement of minutes of activity. Upon selecting an area such as 'minutes of movement' from the main page's general graph, users are directed to this area, where they can see daily, weekly, and monthly data simultaneously, presented in a clear, segmented format. This design choice offers the user additional data only upon request, preventing information overload.

Consistency is maintained with the navigation elements, the bottom bar remains constant for movement through the app, and the profile access is persistent. The addition of a 'back' button introduces a simple way to navigate back to the main page.

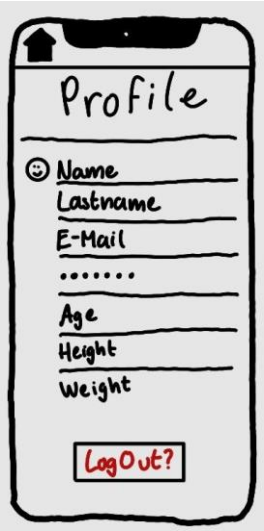


Figure 10: Drawing of the profile page

The profile page displays essential details such as name, email, and password, along with key health metrics like height, age, and weight if needed. This separation from the app's main navigational flow underlines its role as a personal data section, rather than an area for statistics, reachable via a profile button positioned in the upper right of the main screen. Navigating away from the profile can be done by a back button at the top, ensuring that users can easily return to the main interface. Additionally, the inclusion of a logout option within this page allows for a quick user switch on shared devices. This design ensures that the profile page remains a private and secure space where users can manage their account details with confidence and ease.

3.5. Application Implementation

The implementation section of this thesis contains the process from concept to reality, showing the base technologies chosen and the development process. It contains an overview of the selected technology stack, encompassing the development framework, data sources, and critical libraries, along with other tools such as Firebase's authentication service and its Content Management System. Then, it showcases the application's construction, presenting key snippets of the code that demonstrate the assembly of primary widgets, services, and data providers. It is concluded with a practical user manual, guiding readers through the application's usage, and a link to the code repository which includes instructions for downloading and setting up the app, ensuring the reader is able to get the hands-on experience of the application.

3.5.1. Base Technologies

Flutter:

This framework was selected as the ideal candidate for several reasons. Its resemblance to React.js, a framework the development team had previous experience with, made the transition smoother. Flutter's extensive and well-maintained documentation provided a robust foundation for learning and troubleshooting, ensuring that any obstacles encountered during development could be effectively addressed. Although the initial design of the application was Android-centric, Flutter's cross-platform capabilities presented a straightforward path for future expansion to iOS and web platforms. Finally, Flutter's affiliation with Google offered easy and fast integration with other Google technologies, most notably Firebase, simplifying processes like data handling and user authentication. This synergy between Flutter and Firebase was comfortable in creating a cohesive and efficient development environment.

Data Sources:

The application's development was meticulously designed around three critical data sources, each contributing unique metrics required for the app's functions:

- Google Fit: Although presently leveraged for solely sourcing Minutes of Activity data, holds potential for future expansions due to Google's acquisition of Fitbit, positioning it as an expansive health metrics hub.
- Fitbit: It serves as the primary source of health data, including heart rate variability, caloric burn, and sleep duration, among others. The current difference in data structures between Google Fit and Fitbit is acknowledged, and makes it difficult to make a seamless transition between the two sources, but it offers an opportunity for eventual integration as both platforms evolve under Google's ownership.
- Firestore: It is the third used source, managing the application's user-centric data such as individual food logs, educational content, and personalized quizzes. Its relation with Flutter made it a great choice for managing user information and progress, given Firebase's simple integration and Flutter's adeptness at handling Firebase's suite of services.

These data sources, with the parallel use of other technologies, form the backbone of the app, offering a robust and complete dataset that supports the app's features.

Libraries:

Flutter and UI Enhancements

- flutter (sdk): The core SDK for Flutter, providing the framework and tooling necessary for building mobile applications.
- cupertino_icons: Offers a set of iOS-style icons, enhancing the UI with Cupertino (iOS-style) widgets.

Firebase and Authentication

- firebase_core: A required dependency for any Flutter app that uses Firebase, ensuring initialization of Firebase.
- firebase_auth: Provides Firebase Authentication functionalities, supporting sign-in with different providers and managing user sessions.
- firebase_ui_auth: Offers a customizable UI for Firebase Authentication, making it easier to implement authentication flows.
- firebase_ui_oauth_google: A specialized library for integrating Google OAuth with Firebase UI Auth, streamlining Google sign-in processes.
- firebase_messaging: Enables push notifications, allowing the app to receive messages from Firebase Cloud Messaging (FCM).
- firebase_analytics: Integrates Google Analytics for Firebase, offering app usage data collection and insights.
- cloud_firestore: Integrates Cloud Firestore, a flexible, scalable database for mobile, web, and server development from Firebase.
- google_sign_in: Facilitates Google Sign-In, allowing users to authenticate with their Google accounts.

Health and Device Integration

- health: Access health and fitness data from Google Fit servers in a simpler way.
- permission_handler: Manages runtime permissions, essential for accessing health data and device features like notifications and location.

UI and Navigation

- url_launcher: Enables launching URLs, useful for redirecting to web pages or initiating phone calls and emails from the app.
- flutter_web_auth: Assists with implementing web-based authentication, complementing the sign-in and authentication process.
- flutter_custom_tabs: Enhances the browsing experience within the app using custom Chrome tabs, improving UI and navigation.

Data Handling and Utilities

- provider: A state management tool that helps with efficiently managing the app's data flow and UI state.
- intl: Facilitates internationalization and localization, enabling the app to reach a wider audience with multiple languages support.
- crypto: Provides cryptographic hashing functions, ensuring data security and integrity.
- http: Allows making HTTP requests, crucial for network communication with APIs and web services.

Other Tools:

➢ Firebase Content Management System:

Fire CMS is employed to manage the educational content with efficiency. The CMS interface, as shown in the picture below, organizes information into a user-friendly table format that simplifies the process of creating and editing lessons and quizzes. Each entry includes details such as the lesson identifier, the questions assigned to the user, and the sets of correct and incorrect answers. This setup not only facilitates a clear management of educational material but also ensures that any updates or modifications are reflected in the app in real time, thanks to the integration with Firebase.

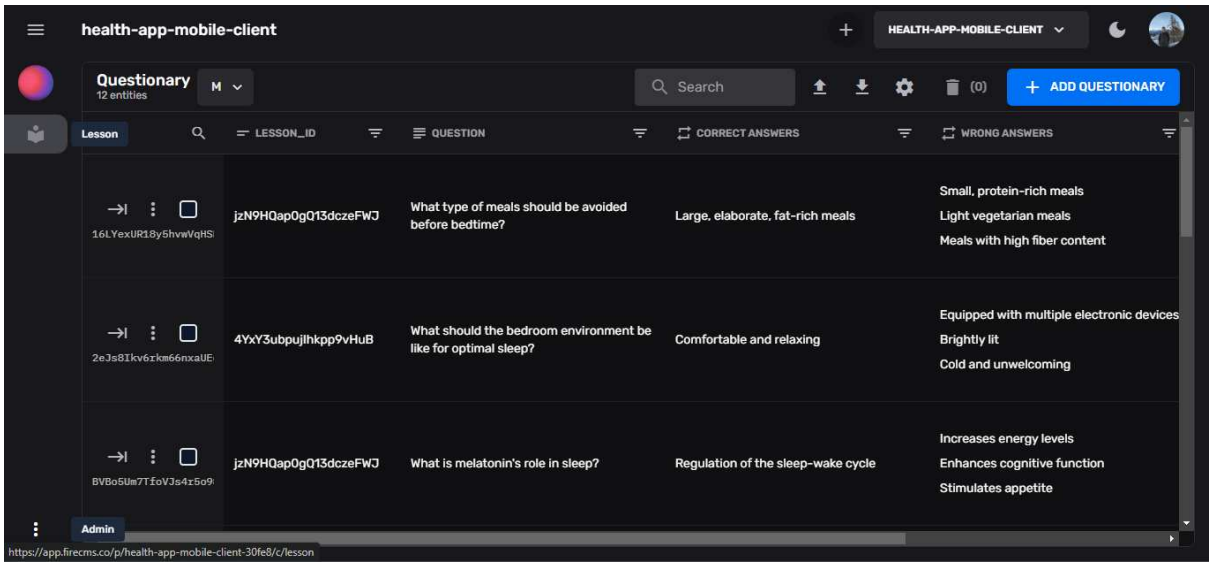


Figure 11: Picture of the CMS with some quizzes

Fire CMS is an easy to use and flexible tool for this project due to its integration with Firestore, allowing immediate updates across the app's system. Its intuitive design allows content managers to effortlessly navigate and modify the app's material without needing too much technical knowledge. Additionally, the system is equipped to handle the growth of the

app, providing scalable solutions for content management. To utilize Fire CMS, administrators log in, add or edit content via easy-to-use interfaces, predefined also using the CMS platform, and save changes that synchronize instantly with the app, maintaining an up-to-date user experience.

➢ Firebase Cloud Messaging Service:

In the context of mobile applications, push notifications are a great tool for engaging users by delivering timed and relevant information directly to their devices. These messages can appear even when the app is not actively in use, prompting the user to take action, such as opening the app or completing a task. The screenshot below, from the Firebase Cloud Messaging interface, shows an example of a platform where these push notifications are managed. It reveals a test notification campaign, highlighting the message content, initiation date, and status, alongside metrics that track the campaign's reach and user interaction.

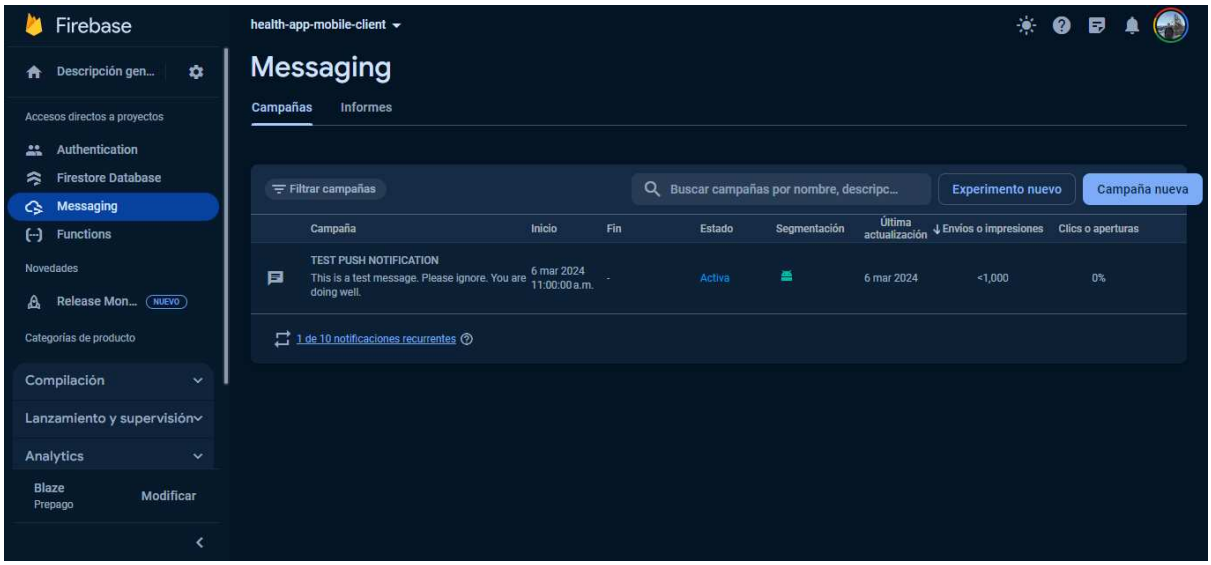


Figure 12: Picture of Firebase console

Firebase Cloud Messaging (FCM) provides a reliable and efficient way to send push notifications. It allows developers to define and send messages to users' devices, which is key for apps that rely on immediate information delivery like health monitoring systems. Notifications can serve multiple purposes: they may remind users to log their meals, encourage daily exercise, or notify them of new content, such as lessons or quizzes within the app. This proactive approach ensures users remain informed and engaged with the app's features and content.

Once integrated into the app, developers can create notification campaigns in the Firebase console, as shown in the screenshot. They can compose messages, define audience segments, schedule delivery times, and measure the impact of each notification sent. The real-time data and analytics provided by FCM also enable continuous optimization of notification strategies, ensuring that the app remains a dynamic and interactive tool in promoting healthier lifestyle choices for its users.

3.5.2. Use Manual

Landing Page

The landing page of the health application presents a user-centric dashboard that tracks and displays key wellness metrics: Activity, Food, Sleep, and Stress. These metrics are represented through individual cards, each corresponding to a specific aspect of health and well-being. The color scheme for each card was consciously selected to reflect the nature of the data: red and yellow signify Activity, green denotes Food intake, blue symbolizes Sleep, and a purple represents Stress levels.

Figure 13: Pictures of home page for different times

Each card on the landing page is dynamically designed to showcase the data for different timeframes: Daily, weekly, or monthly, allowing for a tailored view that fits the

individual's tracking preferences. Navigation through these periods is facilitated by an interactive top bar, which enables an easy transition between dates and time spans. The use of compelling colors not only enhances the visual appeal of the application but also intuitively associates each color with its respective health area, thereby reinforcing the cognitive relationship between color and function.

Also, the application includes a bottom navigation bar as a means to explore the various features offered. It provides fast access to educational content, detailed health tracking, and more. An additional option in the top bar allows for quick access to the user profile and system settings. The design of the landing page, with its intuitive navigation and engaging color palette, ensures that an individual's health information is easily accessible and manageable.

Detail Pages

The following images provided show the detailed view pages for food intake, activity, and sleep metrics within the health application, accessible by clicking on the titles of the main page cards.

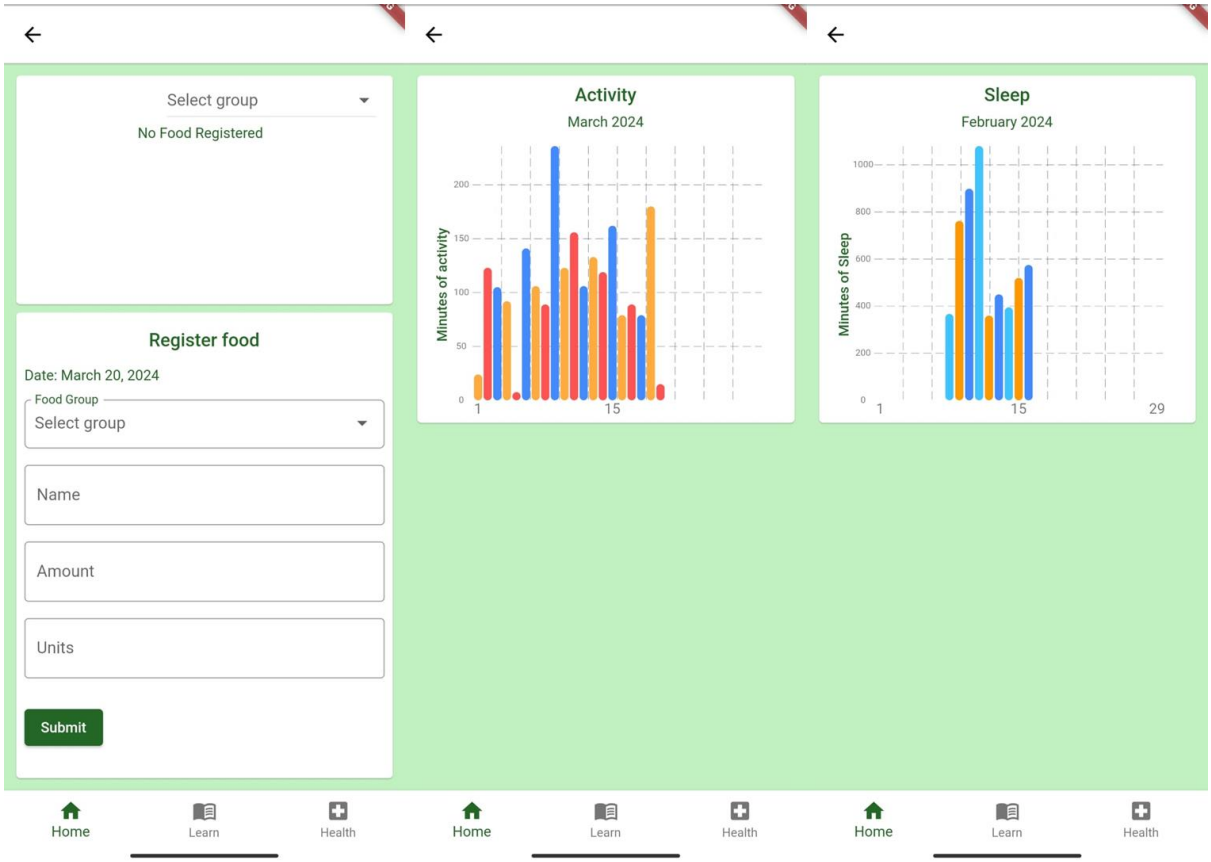


Figure 14: Pictures of the measures in detail pages

The first image depicts the detail page for food intake, featuring a list that displays the types of food consumed on a selected date. The interface includes a form to register new food items, with fields for the date, food group, name, amount, and units. This form aids users in tracking their dietary habits meticulously. The page uses a consistent green color theme, resonating with the nutrition aspect of the app. A top bar facilitates navigation, offering a straightforward means to return to the main page.

The second and third images detail the monthly view for activity and sleep. The activity detail page exhibits a bar graph reflecting the minutes of activity per day throughout the month, using a color scheme of red and yellow to maintain visual consistency with the activity card on the home page. Similarly, the sleep detail page presents a bar graph, despite o some days missing data, indicating days when sleep was not recorded. The color blue is utilized here, aligning with the restful theme of sleep tracking. These graphs provide users with a visual and interactive means to review their monthly progress in activity and sleep.
Additional detail pages for each health category provide more granular insights for each respective time period, designed to present data in the most informative way possible. Whether it's weekly steps, daily calorie intake, or hourly sleep patterns, these pages are designed to offer users a flexible and thorough understanding of their health metrics, fostering an informed approach to personal wellness. The app's structure is thoughtfully organized to cater to different preferences for data consumption, ensuring that each user can access their health information in a way that best suits their needs.

Data navigation

Navigation within the application is assisted by a date selector tool, accessible by clicking on the title in the top bar that displays the current time period. This feature offers users the option of jumping to a specific date, facilitating a more targeted review of their health metrics. The tool presents a calendar view where users can select a day, week, or month, providing a user-friendly way to explore their activity, food intake, sleep duration, and stress levels for any chosen time frame. Once a new date is selected, the relevant data for that period is immediately displayed, ensuring that the user always has access to the most relevant and personalized health information.

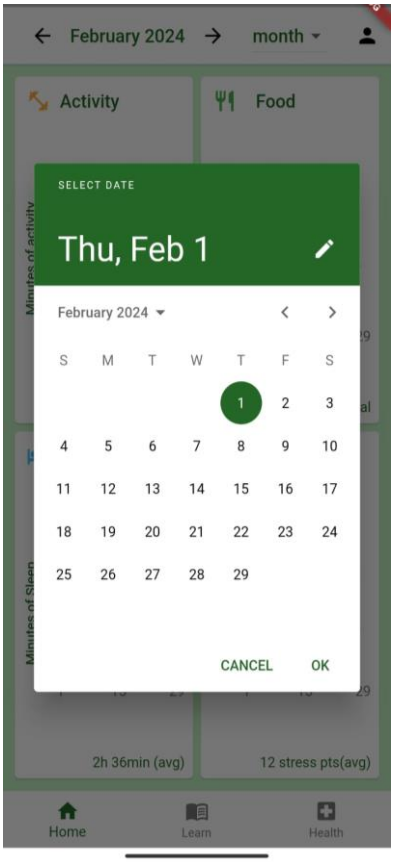


Figure 15: Picture of the date picker usage

Profile

The application offers a generic user management experience through two distinct pages. The profile page shown in the following picture is a private space where users can view their personal data, including their name and profile picture, ensuring that their information is up-to-date and accurate. Options to enhance account security are readily available, with functionalities that allow users to sign out, enable additional sign-in methods for convenience, or take decisive actions like deleting their account entirely. On the other hand, the sign-in page serves as the gateway for users entering the application. It's the initial screen for those who haven't logged in, presenting a clean interface for authentication. Users can sign in using their email and password, recover a forgotten password, or utilize the quick access 'Sign in with Google' feature. This landing page emphasizes ease of access and security, making the process of starting a session straightforward and user-friendly.

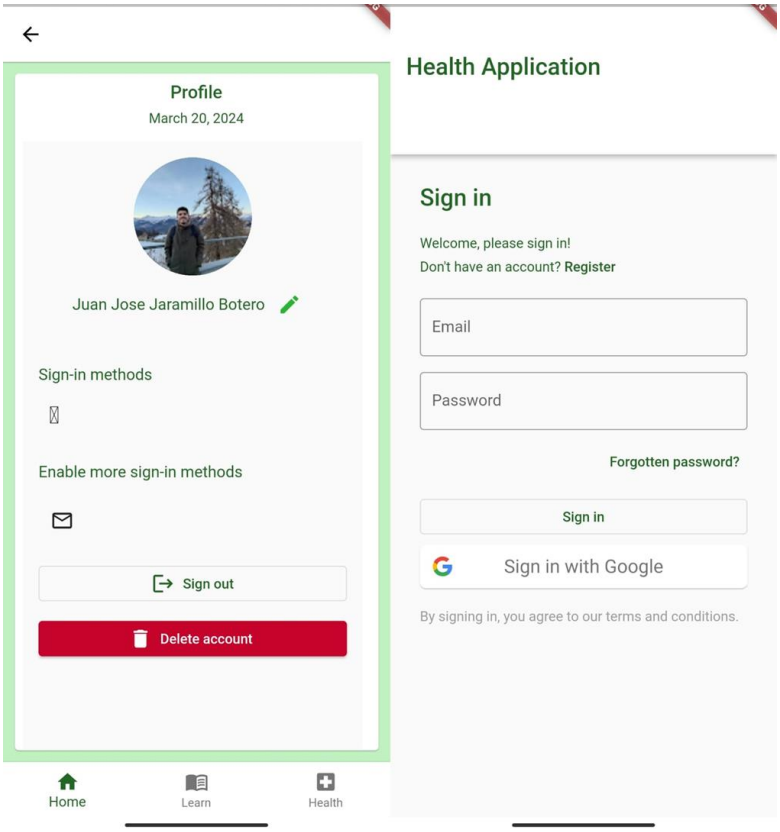


Figure 16: Picture of the profile and sign in pages

Lessons and Quizzes

The application's educational component contains a collection of health-related lessons and quizzes, intended to improve a user's understanding and application of healthy habits. The lesson page displays a list of educational topics, each accompanied by a brief synopsis and an indication of completion, as represented by a checkmark for lessons and quizzes successfully finished. The platform is designed to assign lessons sequentially; once a user completes a quiz related to a lesson, a new lesson becomes available. This ongoing educational loop ensures that users have constant access to new knowledge until they have exhausted the content pool.

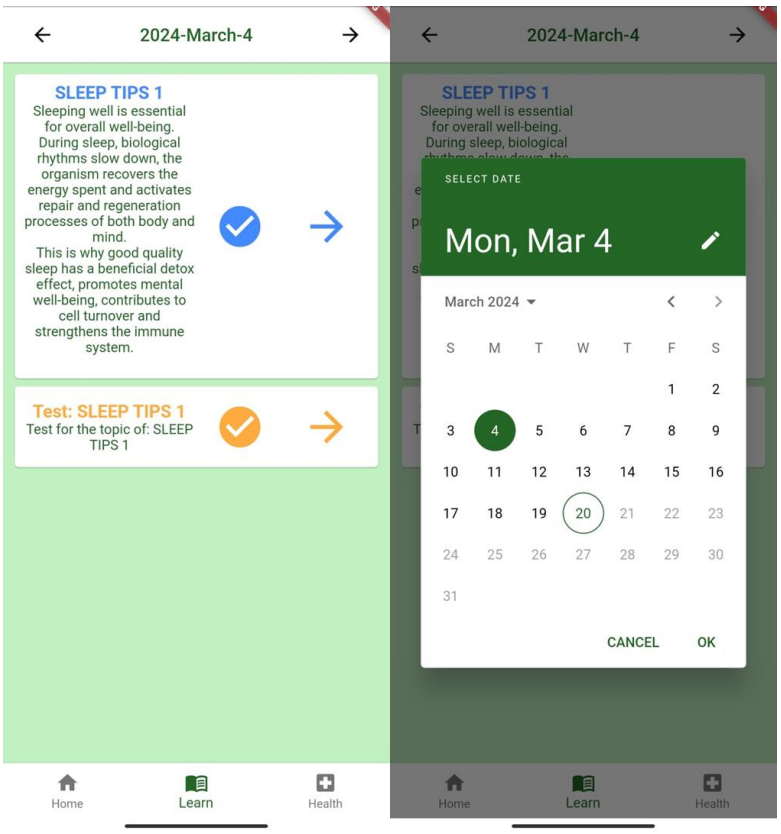


Figure 17: Pictures of the Quizzes and Lessons page and change with date picker

An interactive date picker, mirroring the functionality found on the main page, is also incorporated within the lesson section. This tool permits users to select a specific date and review the lesson presented on that day, should they wish to revisit the content or check for completion. It is an instrumental feature in enabling users to seamlessly navigate through their educational journey, offering them the flexibility to engage with the learning material at their own pace and according to their personal schedules. The visual consistency across different

sections of the app, such as the use of color-coded checkmarks and the uniform date navigation tool, underscores the app's commitment to providing a cohesive and user-friendly experience. In the following picture we can see the different screens and sections of quizzes and lessons. One of the screenshots showcases a snippet from a lesson about sleep, titled "Sleep Tips 1", where valuable advice and tips are displayed. To facilitate learning at one's own pace, navigation buttons labeled 'Previous' and 'Next' are positioned at the bottom, allowing the user to move through different sections of the lesson.

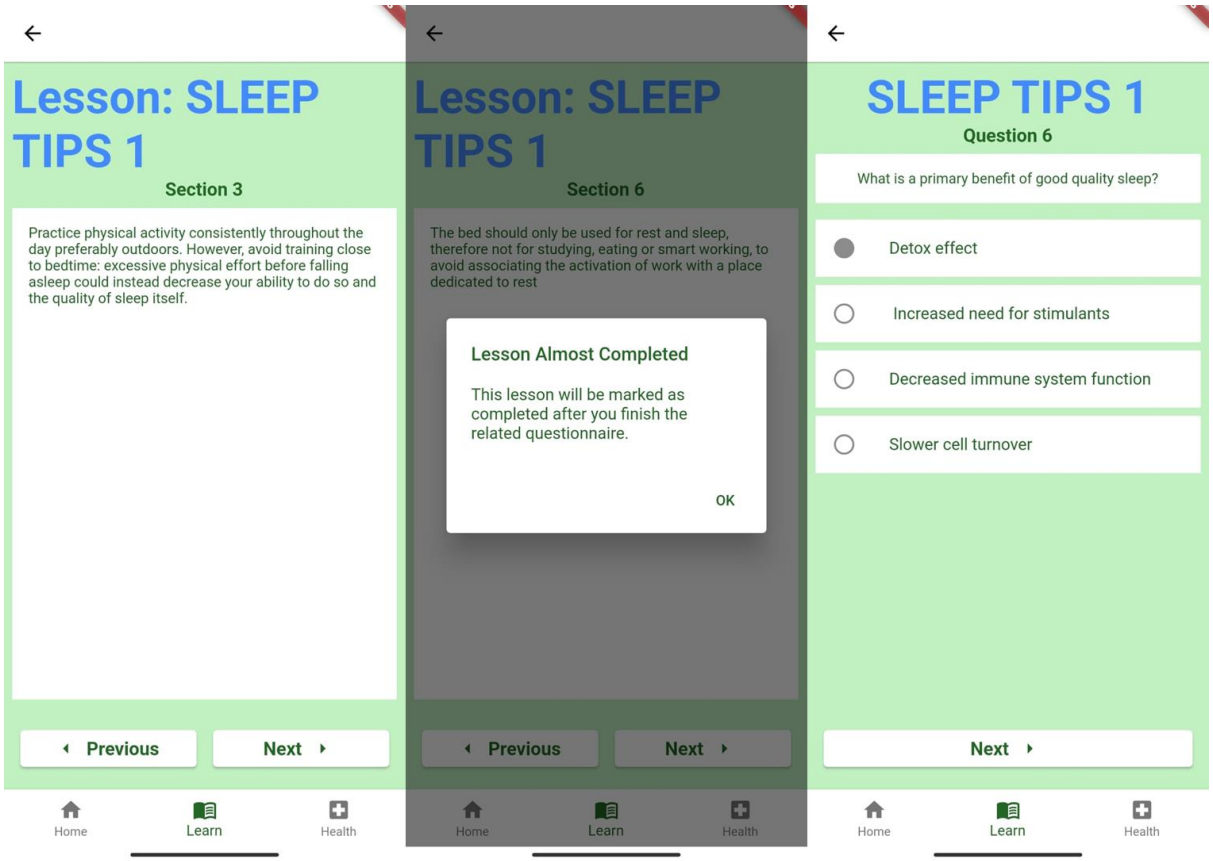


Figure 18: Pictures of different lessons and quizzes

Upon completing the lessons, a prompt appears, notifying the user that to mark the lesson as completed, they need to finish the associated quiz. This ensures the lessons are not just read but understood. The quiz component, tied directly to the lesson content, presents questions and multiple-choice answers, requiring users to apply what they've learned. One such screen displays a question from "Sleep Tips 1" with options to choose from, and once an answer is selected, the user can proceed through the quiz with the 'Next' button.

Both the lesson and quiz screens are framed within the application's consistent navigation system, featuring a top bar for a quick return to the main lessons page and a bottom bar for

accessing other parts of the app. This uniform design approach ensures that regardless of whether a user is in the middle of a lesson or a quiz, they can easily transition between learning and other health-tracking features within the app.

Output Variables

The screenshot captures the page within the health application that consolidates various biometric data points, providing users with a snapshot of their current health status. Displayed metrics include 'Breathing Rate', 'Average Skin Temperature', 'Average SpO2', 'Heart Rate at Rest', and 'Heart Rate Variation'. These outputs are crucial indicators of a user's well-being and are derived from daily activities, sleep patterns, stress levels, and nutritional intake. Currently, the app sources this data from the Fitbit database, offering users convenience and insight, even if personal measuring devices are not at hand. While the values are presently hard-coded for demonstration purposes, the framework is set for future integration with real-time data. Continuity in user experience is maintained with the persistent bottom navigation bar, allowing users to transition smoothly between viewing their biometric outputs and other features of the application.

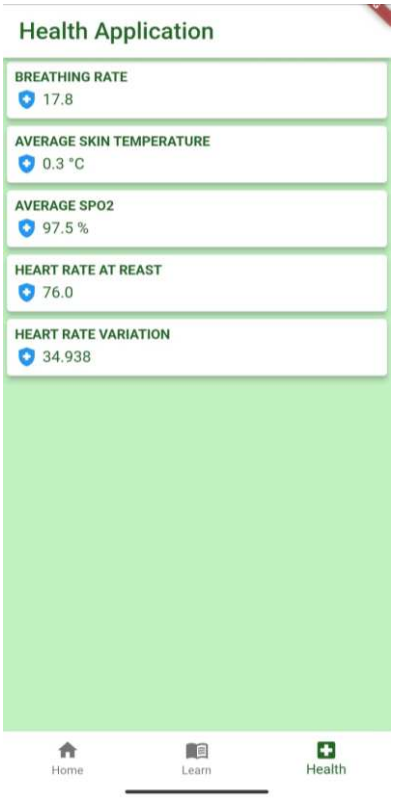


Figure 19: Picture of the output variables in the app

Permission Requirement

The code snippet illustrates how the application requests user permissions to access health data from servers like Fitbit and Google Fit. These permissions are critical, as they respect user privacy by only accessing data for which explicit consent has been given.

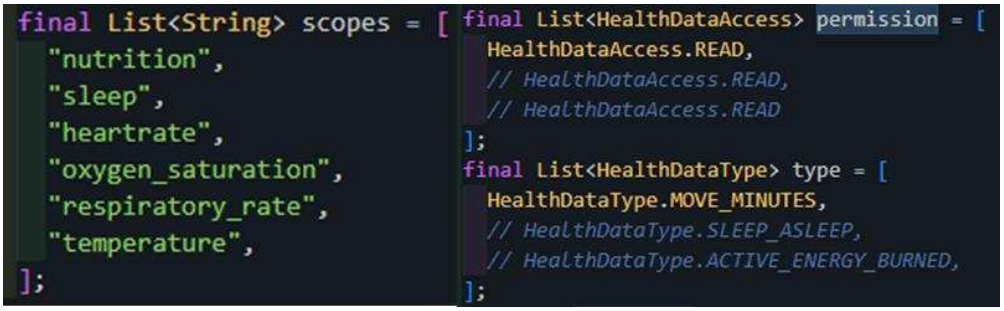


Figure 20: Picture of the permits and scopes used by google fit and fitbit

For the Fitbit integration, a list of HealthDataAccess permissions is defined, which, when the application is run, will prompt the user with an external page asking for authorization to read their health data. The specific types of data that may be requested, such as activity minutes or sleep analysis, are declared in a separate list. This approach ensures that the user is aware of and agrees to the exact data types the application will access. On the Google Fit side, the application similarly specifies the data types it requires access to, with HealthDataType.MOVE_MINUTES indicating the app's intention to retrieve information related to physical activity duration. Here, only read access is requested, reflecting the application's need to view the data without altering it.

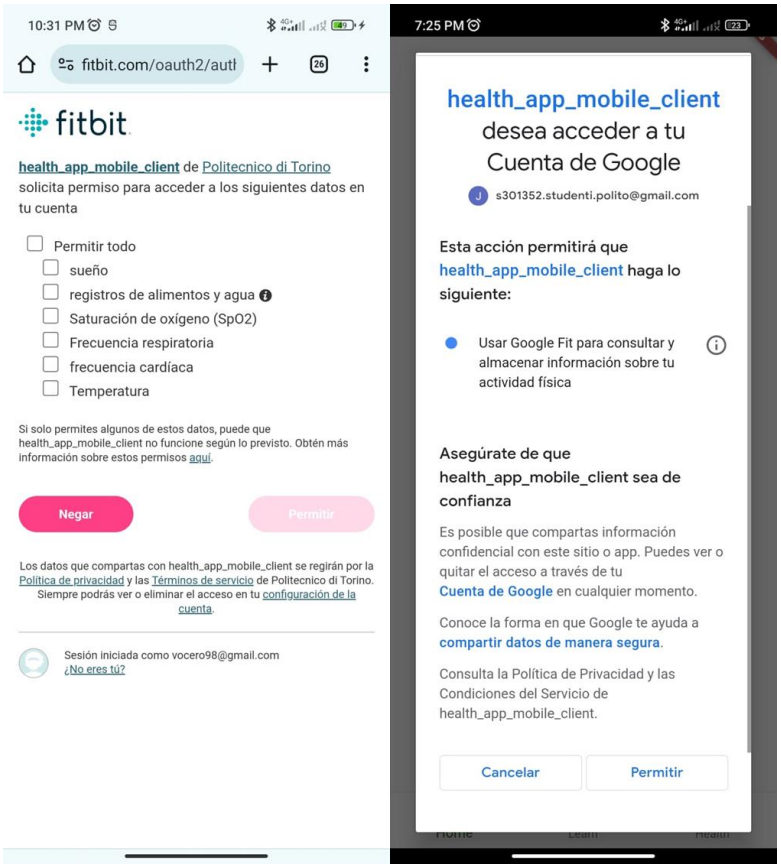


Figure 21: Picture of the permission requirements of Google and Fitbit

The screenshots present the authorization processes for two prominent health data services: Fitbit and Google Fit, as part of the health app's setup. The first image displays the permission request page from Fitbit, where the app asks the user to grant access to specific health data on their account, such as sleep, food and water logs, oxygen saturation (SpO2), respiratory rate, heart rate, and temperature. Users have the option to permit all or select individual data points, with clear indications that limited permissions might affect the app's functionality.

The second screenshot illustrates the Google Fit permission request, where the health app seeks consent to view and store information regarding the user's physical activities via their Google account. This permission ensures that the health app can access relevant activity data managed by Google Fit. Both screens provide options for the user to either deny or allow these permissions, emphasizing user control over data sharing. They also reassure the user of their privacy by linking to the respective privacy policies and terms of service, enabling informed consent within the secure frameworks established by Fitbit and Google.

Push Notifications

The screenshot shows a push notification from the health application, which is a practical demonstration of the reminder feature in action. This specific notification is a test message, part of a scheduled routine set to alert all Android users at 5pm daily. Push notifications like this one are extremely useful as they serve as an interactive touchpoint between the app and the user. They are designed to provide timely prompts or health tips, ensuring that users remain engaged and motivated throughout their wellness journey.

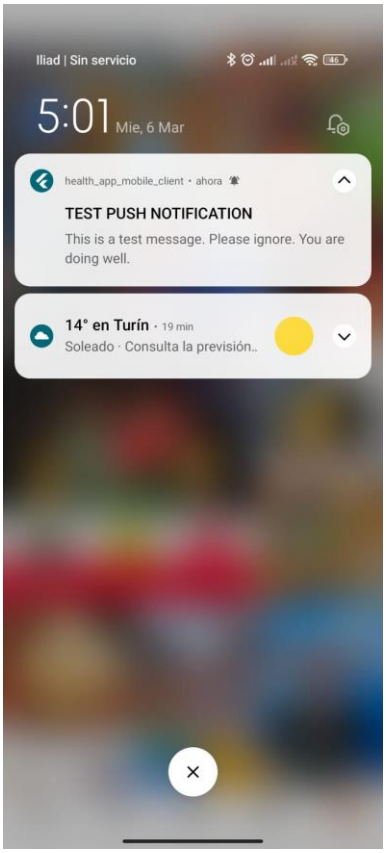


Figure 22: Picture of a notification sent by the application

In this example, the notification is a straightforward message meant to be a placeholder for more personalized content. The real power of such a feature lies in its potential to deliver customized reminders for workouts, meal planning, meditation sessions, or even to prompt users to check the app for new lessons or updates on their health stats. The regular appearance of these notifications can help establish consistent patterns of behavior, which are crucial for users seeking to develop and maintain healthy habits.

3.6. Next Steps

Certain improvements and functionalities were not within the reach of the initial development phase. This section shows an array of prospective features and refinements that, while not part of the original design, stand as valuable expansions to the application's capabilities. These possible additions are not merely incremental improvements but elements that could significantly get a better user experience, and broaden the application's utility. This chapter is dedicated to outlining these potential enhancements, explaining their relevance, and envisioning their impact on the trajectory of the app's evolution. Here are a few ideas for new features:

- Programmed Reminders Enhancement: Programmed reminders stand out as a key addition to the application, taken from their presence in other health platforms. Envisioned as a dedicated page filled with customizable alarms, this tool would enable users to set notifications for specific tasks with titles, descriptions, and personalized identifiers like colors or labels. These reminders would be scheduled to prompt users at predetermined times on selected dates or intervals. Upon activation, an audible push notification would be dispatched, grabbing the user’s attention whether they are currently engaged with the app or not. This proactive functionality would serve as a call to action, encouraging users to fulfill their health-related tasks, be it for medication, exercise, or dietary habits, thereby assisting in their journey towards better health.
- Strike Counter: Within the health application, it would be introduced a dynamic element of gamification to add regular user engagement. Drawing inspiration from successful models like Duolingo's streak feature, the strike counter would act as a visual motivator, pushing users to return to the app daily for their health education sessions. Each consecutive day a user completes a lesson, their strike count would increase, symbolized by an emblematic label, like a fire that keeps burning. This icon would be prominently displayed within the app interface, serving as a badge of consistency and dedication. The objective is to incentivize users not just to open the app, but to actively participate in and complete the educational content, thereby adding a routine of learning and self-improvement into their daily lives.
- Extensive Lessons: The existing lessons, provided by academic collaborators, serve as a base framework from which a more extensive library of content can be developed. To truly harness the app's potential, it is expected that a more complex suite of lessons and quizzes be curated by qualified health professionals such as doctors and nutritionists.

These experts would ensure the information is not only accurate but also encompasses a wide spectrum of health and wellness topics.

In addition to the content expansion, incorporating a feature that cites the sources of information during lessons would greatly enhance the app's credibility and educational value. Users could then easily reference the origins of the health advice and data presented, reinforcing trust and transparency. Also, introducing a functionality to revisit and review completed lessons would allow users to refresh their knowledge, solidifying the learning outcomes.

- Self Register Form: A manual data registration feature would allow users to manually input health metrics directly into the app. Envisioned as a user-friendly addition, a plus icon ('+') on the main page would lead to a form where users can enter various health statistics, from physical activity to dietary intake. The data entered would then be stored securely on servers, including the option to integrate with Google Firebase for robust data management.

Some other ideas are related to the improvement of other areas of the application or of the program as a whole, by making sure it is stable and scalable:

- Multiple Sources for Data: The integration of multi-source data aggregation presents a significant upgrade for the health application, enabling users to pull the same health metrics from various platforms for a more complete overview. While this feature may necessitate additional server queries, the trade-off comes with the benefit of data cross-verification and user choice for the source of origin of their data. By processing and standardizing diverse data sets, users could not only compare but also select their preferred data source. The app could further enhance user convenience by storing this homogenized data on its own server, adding access and improving the overall user experience. This level of data integration would not only provide a more robust picture of a user's health but also create confidence in the accuracy of the information provided.
- Testing: The incorporation of a comprehensive suite of unit and integration tests is an indispensable next step for the health application, serving as a base for maintaining software quality. This addition involves designing tests that meticulously evaluate individual components (unit tests) and the seamless operation of those components within the entire system (integration tests). By automating these tests, developers can rapidly identify and rectify bugs or malfunctions, ensuring the application performs

reliably before each release. Not only does this practice drastically reduce the risk of deploying defective software, but it also upholds user trust by providing a consistently smooth, efficient, and error-free experience.

3.7. Conclusions

- Enhanced User Experience through Intuitive Design: The design and implementation of the health application placed a strong emphasis on generating user engagement through an intuitive and visually appealing interface. This strategic approach was driven by a deep understanding of user needs and behaviors, identified during the initial phase of the project through analysis and study of existing applications within the health and wellness domain. Taking the persuasive design principles outlined by Oinas-Kukkonen and Harjumaa, the app's interface was crafted to simplify user interactions and make health tracking an engaging part of daily routines. The application's design was not only guided by the functional and non-functional requirements gathered at the start but also took inspiration from the aesthetic and usability examples set by leading apps in the market. This ensured that the user experience was at the keystone of the project, adding consistent interaction with the app’s features, from personalized health insights to educational content, thus enhancing the overall effectiveness of the app in supporting users' lifestyle changes.

- Robust Architecture and Scalable Technology Stack: The application’s robust architecture and technology stack, centered around the Flutter framework and Firebase services, laid the base for a system that is both scalable and maintainable. Flutter was chosen for its versatility and the ease with which developers could create a cross-platform app with a single codebase, ensuring a fluid user experience on Android devices. The decision to use Firebase services, including its authentication features, real-time database, and cloud functions, was key in building a secure and efficient backend infrastructure. Additionally, the integration with other technologies such as Google Fit and Fitbit for health data sourcing, Cloud Firestore for scalable database solutions, and a Firebase Content Management System (CMS) for dynamic content updates, founded the app’s capacity for handling complex data workflows and user

interactions. The inclusion of libraries for data visualization, and state management further enhanced the app’s functionality, making it well-equipped to adapt and grow in alignment with advancements in health monitoring technologies and user expectations.

- Alignment with Digital Health Trends and Market Expansion: The project's comprehensive scope and alignment with prevailing digital health trends underscore the app's significance within the modern health ecosystem. By addressing the growing demand for accessible and personalized health monitoring solutions, the app positions itself as a key player in the digital health market. Its development was timely and in tune with the shift towards more proactive and informed health management practices among consumers. The app's potential for expansion into broader markets and demographics is bolstered by its scalable architecture and the universal appeal of its features, from health tracking to educational content. With the health and wellness sector continuing to evolve, driven by technological innovation and changing consumer behaviors, the app stands ready to adapt and expand its offerings. The project's foresight in designing for scalability and flexibility ensures that it can embrace new opportunities and challenges within the health tech landscape, meeting and exceeding user expectations in a rapidly changing world.

4. Bibliography

- *APP FITBIT*. (2024). Fitbit. Retrieved February 20, 2024, from https://www.fitbit.com/global/it/technology/fitbit-app
- *The Complete List of EVERY Duolingo Language in 2023*. (2023, February 20). duoplanet. Retrieved February 20, 2024, from https://duoplanet.com/duolingo-languages-list/
- *Duolingo: Language Lessons - Apps on Google Play*. (2024). Google Play. Retrieved February 4, 2024, from https://play.google.com/store/apps/details?id=com.duolingo&hl=en_US&gl=US
- Fogg, B.J. (2003). *Persuasive technology*. Morgan Kaufmann Publishers. https://books.google.it/books?id=r9JIkNjjTfEC&lpg=PP1&hl=es&pg=PP1#v=onepage&q&f=false
- *Fogg Behavior Model | Behavior Design Lab*. (2024). Behavior Design Lab. Retrieved February 5, 2024, from https://behaviordesign.stanford.edu/resources/fogg-behavior-model
- Gallucci, N. (2019, May 2). *Forest is a useful app that helps you go phone-free by inspiring you to plant trees*. Mashable. Retrieved February 20, 2024, from https://mashable.com/article/forest-app-productivity-focus-review
- *Gamification in mobile-assisted language learning: a systematic review of Duolingo literature from public release of 2012 to early 2020*. (2023, May 19). Taylor & Francis Online. Retrieved February 20, 2024, from https://www.tandfonline.com/doi/full/10.1080/09588221.2021.1933540?scroll=top&needAccess=true
- Gilbert, J. (2012, August 28). *Sleep If U Can: Android Alarm Clock App Won't Stop Ringing Until You Take A Very Specific Photo*. HuffPost. Retrieved February 20, 2024, from https://www.huffpost.com/entry/sleep-if-u-can-android-alarm-clock-photo_n_1836068

- Google. (2024). *Google Fit*. Google. Retrieved February 20, 2024, from https://www.google.com/intl/en_us/fit/
- *Google Fit: Activity Tracking - Apps on Google Play*. (2024, February 1). Google Play. Retrieved February 4, 2024, from https://play.google.com/store/apps/details?id=com.google.android.apps.fitness&hl=en_US&gl=US
- *Google just launched Heart Points. Here are 5 things you need to know*. (2018, August 21). American Heart Association. Retrieved February 20, 2024, from https://www.heart.org/en/news/2018/08/21/google-just-launched-heart-points-here-are-5-things-you-need-to-know
- *Headspace: Sleep & Meditation - Apps on Google Play*. (2024). Google Play. Retrieved February 5, 2024, from https://play.google.com/store/apps/details?id=com.getsomeheadspace.android&hl=en_US
- Lum, P. (2019, 5 29). Pokémon Sleep: game unveiled that 'turns sleeping into entertainment'. *The Guardian*. https://www.theguardian.com/games/2019/may/29/pokemon-sleep-game-unveiled-that-turns-sleeping-into-entertainment
- *MyFitnessPal: cuenta calorías - Apps en Google Play*. (2024). Google Play. Retrieved February 5, 2024, from https://play.google.com/store/apps/details?id=com.myfitnesspal.android&hl=es_419&gl=US
- Oinas-Kukkonen, H., Hasle, P., Harjumaa, M., Segerståhl, K., & Øhrstrøm, P. (Eds.). (2008). *Persuasive Technology: Third International Conference, PERSUASIVE 2008, Oulu, Finland, June 4-6, 2008, Proceedings*. Springer. 10.1007/978-3-540-68504-3_15

- Ongaro, F. (2024). *Il blog di Filippo Ongaro - Articoli, Approfondimenti, Notizie*. Metodo Ongaro. Retrieved February 4, 2024, from https://www.metodo-ongaro.com/blogpage
- *Ospedale Universitario di Verona, chi siamo*. (n.d.). Azienda Ospedaliera Universitaria Integrata Verona. Retrieved February 2, 2024, from https://www.aovr.veneto.it/azienda/chi-siamo
- Porchaska, J., & Velicer, W. (1997). *The Transtheoretical Model of Health Behavior Change* (Vol. 12). 10.4278/0890-1171-12.1.38
- Sommerville, I., & Sawyer, P. (1997). *Requirements Engineering: A Good Practice Guide*. Wiley. https://www.wiley.com/en-us/Requirements+Engineering%3A+A+Good+Practice+Guide-p-9780471974444
- Torning, K., & Oinas-Kukkonen, H. (2009). *Persuasive system design: state of the art and future directions*. 10.1145/1541948.1541989
- *University os Sydney, about us*. (n.d.). The University of Sydney. Retrieved February 2, 2024, from https://www.sydney.edu.au/about-us.html
- OpenAI. "ChatGPT: Language Model for Text Generation and Assistance." OpenAI, 2024. Accessed [2024]. URL: https://www.openai.com. Note: ChatGPT was utilized in the preparation and refinement of this thesis to assist in generating ideas, ensuring clarity, and improving overall coherence.