# Custom Personal Informatics System

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**Abstract:** The integration of personal informatics (PI) systems into everyday routines holds significant potential for enhancing individual health, well-being, and productivity. Our project, aimed at university students, leverages PI software to monitor and analyze personal data to foster self-improvement and awareness. Through primary research involving surveys and interviews, we identified key metrics that resonate with our target audience—sleep, water intake, step count, and productive hours. These metrics not only align with common health guidelines but are also among the most sought-after data points for students looking to balance their academic and personal lives. Our system is designed to encourage user engagement through easy data entry, intuitive interfaces, and integration with external devices like Fitbit for automated data collection. By providing real-time feedback and visual progress indicators, the system aims to motivate users to develop healthier habits and achieve personal goals. This paper discusses the development process, including design considerations, Agile methodology, user feedback integration, and challenges faced during implementation. By focusing on a user-centered design and streamlined functionality, our system offers a practical tool for students to manage and enhance their daily routines.

# Contents

# 1 Introduction

Increasingly, medical advice and research is showing that minor changes to an individual's daily routines can have positive effects on their overall health, wellbeing and productivity. For example, we are often reminded of the advantages of walking 10,000 steps (Tudor-Locke et al., 2011), sleeping for at least 7 hours (Watson et al., 2015) and drinking at least 6 cups of water (NHS, 2023) every day. However, as discussed by Madore and Wagner (2019), processing multiple tasks concurrently can lead to reduced efficiency. Therefore, tools to aid in the tracking and pursuing of these personal development goals are likely to help an individual reach their goals more effectively.

PI(Personal Informatics) software is software designed to help collect and analyse data about an individual with the aim of promoting self-understanding and betterment. A PI system could be an ideal solution to this issue as it could be very useful in allowing an individual to monitor and streamline their progress towards their goals for self-improvement.

However, in designing a PI system it is important to ensure user engagement; if a user stops using a system then the system cannot help them. Kersten-van Dijk et al. (2017) found that the studies they reviewed which discussed users dropping out of using a PI system reported dropout rates of 7-44%. This suggests that a significant proportion of people might not feel motivated to continue using PI software. Furthermore, Jones and Kelly (2018) found that presenting users with too much information could leave them feeling overwhelmed; Rapp and Cena (2016) found that first-time users of PI systems could find the act of recording their data burdensome; and Potapov et al. (2021) discovered that teenagers often found PI systems either controlling or confusing depending on the way they were designed.

Fortunately, some of these studies, as well as many others, have investigated how to make a PI software system effective for its users and proposed ways of designing systems with this in mind. For instance, Jones and Kelly (2018) suggested that, to avoid overwhelming users, a system should only show the user information that is interesting to them. They found that 'interesting information' was that which was surprising, useful or statistically significant. It was also found that users found it more interesting when insights could be provided between aspects of their life, rather than within them. Rapp and Cena (2016) recommended providing users with tailored summaries and targets; control over their data; and reviews of past data. In this way they suggested that feelings of freedom and nostalgia might be fostered, increasing positive views and connections with the software. Potapov et al. emphasise the importance of finding an appropriate balance between constraints to orient the user towards positive goals and freedom to allow them to use the tool in a way that suits them. Additionally, a study by Loerakker et al. (2023) showed that promoting self-compassion through the design of a Personal Informatics system can foster positive self-reflection while reducing the chances of rumination and cessation of goal pursuit. The study showed that framing data positively can promote self-compassion. For example, highlighting positive achievements rather than criticising poorer performance.

Our intention is to create a PI system aimed at current university students. To decide on a list of metrics for our system to track, we investigated the interests of our chosen demographic by means of a Google Forms survey. The survey, which was sent to students online, revealed that 60% of respondents were most interested in tracking their health, followed by 30% who were most interested in tracking their own learning and development. In addition, when asked to rate their interest in tracking their data for self-improvement on a scale of 1-10, 55% of participants rated their interest at 8 or above. This reinforced our belief that a PI system would be popular among our target audience. We also conducted some individual interviews of students involving more specific questions about health and desirable PI system features. These interviews revealed an interest in graphs and a simple user interface which we will take into account when designing our application. All the students we interviewed also expressed a desire to alter the number of hours of sleep they got on a daily basis. Based on these investigations, as well as research into Fitbit and Garmin software, we decided that our system would track hours of sleep, water intake, steps taken and hours spent productively.

Our system will allow data to be entered manually. Some metrics will also be able to collect data automatically via the Fitbit API to reduce the burden of data entry. Additionally, our software will allow users to set personal goals and see useful data about their performance. This data will be able to showcase correlation in each metric against time individually and between separate metrics. This functionality will all be accessed via a desktop application with a graphical user interface. We hope that, by tracking these four important aspects of student life, our system will provide interesting and useful insights that guide our users towards better health and productivity while ensuring that they are not overwhelmed by too much data or the need to balance their goals.

# 2 Agile Software Process Planning and Management

To carry out this project in an efficient and organised manner, we followed Agile practices and values using the Scrum framework. This involved using a series of week-long sprints to break up and work through the continuously evolving product backlog. Between each sprint, a meeting was held to discuss the outcome of the previous sprint, go over any changes to the product backlog, produce a sprint backlog and divide this sprint backlog between the group members for completion during the next sprint. To maintain clarity and access to information, minutes were taken of these meetings and stored in the project GitHub repository. This meant that developers could always access information about the progress of other developers and their allocated tasks (See Appendix x). During sprints, group members worked either individually or as part of a smaller group to complete their allocated element of the sprint backlog. Regular scrum meetings were also used to allow group members to communicate progress, plans, obstacles and key information. We assigned a scrum master to gain a full understanding of Agile values and methodologies and ensure the group's adherence to them. A product owner was also chosen to be in charge of managing the product backlog and organising sprints.

Our first sprint was devoted towards research into PI systems and what students wanted in one. Three group members were assigned to researching PI systems, two to market research, two to gauging interest in students, one to compiling the initial project backlog and one to researching the most appropriate programming language to use for the project. By the end of the week, all members had fulfilled the duties assigned to them. The research was discussed as a group and used to produce the idea for our system. As this idea evolved, it was converted into a list of functional requirements and added to the product backlog.

The second sprint consisted of designing and beginning to create our application. A member of the team set up a framework for our project on GitHub and two team members were assigned the task of creating a UI (User Interface) diagram for our application. Having done this, the UI designers presented the result in a scrum meeting and, based on this, other members of the group created a coding plan, started creating the UI and implemented some basic functionality. Meanwhile, a group member worked on creating a database and demonstrating the use of it; another researched and showcased the use of a suitable API; and the remaining people began the writing of the report. The scrum meetings held throughout the week were key in ensuring that all the programmers could stay abreast of any important changes made by others with impacts on their own work, as well as allowing the sharing and discussion of issues. At the end of the sprint, all available team members attended a Google Meet meeting in which all progress was discussed. The sprint was very successful, with every individual achieving their designated goals. Based on the API research conducted, it was decided that the Fitbit API was most suitable for our system. Additionally, it was concluded that an alternative database design would be more efficient. These evolutions of the idea of our project meant that the product backlog was updated.

The sprint that followed largely prioritised the implementation of desired functionalities from the product backlog. Five members of the group were individually allocated to specific aspects of the program. This included implementing the productivity tracker, achievements, goals, graphs and the Fitbit API integration. One developer was also assigned to redesigning the database to be more efficient. The other available group members were given sections of the report to work on. During the frequent scrum meetings in this sprint, reporting back helped maintain a full understanding of the latest changes among the programmers. Unfortunately, due to technical difficulties, the sprint backlog was not entirely completed. These incomplete tasks were added to the sprint backlog of the next sprint. Other than some software features, all tasks were completed successfully and the next sprint was discussed and planned as usual.

The fourth sprint had very similar aims to the previous one, with team members allocated to report writing and the development of features, including those which were not completed during the previous week. By the end of the sprint, more elements of our system's functionality had been implemented and the report completed further so these parts of the product backlog were marked as complete. However, the design section of the report and the achievement functionality of the system were not completed due to other commitments and the work tracking section was not fully functional due to technical difficulties. The completion of these requirements was moved to the following week's sprint.

The fifth, and final, sprint targeted the completion of as yet unimplemented features and work on the report document. These responsibilities were split so that roughly half the group was working on each. As well as the programming of parts of the system, focus was also placed on merging all the functionality together to create our system as a whole. To align the completion of the project with our deadline and allow enough time for the required work, this final sprint took place over 11 days, between the 22nd of April and the 3rd of May. By the end of the sprint, the entirety of the sprint and product backlogs had been completed and the project as a whole was finished.

By following the Scrum framework we were able to efficiently divide our work into manageable quantities and maintain constant progress towards a timely completion, clearly demonstrating the effectiveness of the methodology.

# 3 Specification of Software Requirements

This section establishes the core requirements for our Personal Informatics (PI) system, focusing on helping students keep up with their fitness and study goals. We utilised feedback from surveys, talks with users, market research, and academic research articles to figure out what features our system should have. Our aim is to make a system that assists students in improving both their physical health and studying habits whilst not being overly invasive.

In the following sections, the notation *SRQ* will be used to denote requirements from the coursework's specification, while *ARQ* will represent Additional Requirements. Refer to Section 3.10 for a quick-reference table of requirements.

## 3.1 Gathering System Requirements

Initially, we asked people what features they would look for in an personal improvement application. From these interviews, we identified that most students use PI systems for tracking their fitness (60%) and their learning progress (30%), with the other 10% being interested in their environmental impact. This helped us decide which area of personal informatics our system should focus on. Next, we looked at what users stated about our initial ideas as well as comparing our ideas to expert findings from our listed articles (SRQ 3.1, 3.2). Additionally, many students told us they prefer applications that are intuitive but still allow for great insight and control into goals and targets. Also, they wished to connect with their friends and peers through the app and liked the idea of seeing all their information in a single area. Furthermore, we also researched into competitor systems (such as garmin and fitbit) to identify both good and bad features of these systems .

After this, we made an initial requirement list of what functionality our app must contain (SRQ 2.1, 2.3) based on the data gathered. We must ensure our system is perfect for tracking health and study time, allows users to share their progress with friends, and keeps all their data safe and private. Furthermore, we must reguarly reflect on our requirements to ensure that they properly suit our vision for the system, adapting them whenever tests, feedback, or other factors suggest so.

## 3.2 Specific Domain of Application

Our PI system is intricately designed with a student demographic at its core, addressing their unique challenges such as managing academic deadlines alongside maintaining a balanced lifestyle.

Students grapple with the dual challenges of academic accountability and physical well-being. The system shall provide a suite of tools for effective study habits and simple health tracking (SRQ 2.1).

## 3.3 Data Fields Chosen

Our app is tailored towards individuals who require assistance managing their time healthily as we are aware that a large proportion of students have difficulty maintaining a healthy work-life balace. Our app aims to help them track key aspects of the student lifestyle. The fields we have chosen to track as well as how they shall be accessed are as follows (SRQ 5.1, 5.3):

- **Tracking sleep time**: The average student struggles to manage sleep, studying, and being social and out of these three, sleep is usually the area in which students choose to disregard in order to create more time. However, a lack of sleep can be detrimental on all aspects of life and as such it is imperative that we ensure our users are aware of how little sleep thay may be getting across a given time frame. We are aware that some students may also be getting too much sleep which can lead to them feeling lethargic throughout the day and as such our system should also provide a solution for these users. Sleep quality also plays a large role in this but is incredibly difficult to track unless specialist equipment is used. Additionally, it is usually influenced by factors our system cannot control such as noise from other tenants and temperature.

  This field will require a user to manually enter their data. Allowing a user to set goals for this field will enable them to prioritise the quantity of sleep they are getting each night. Our system should enable our users to obtain a consistent, healthy sleep pattern

- **Tracking step count**: The average student spends a large proportion of their day sedentry, whether that be from napping after a lecture, studying hard for an exam, or sat behind a computer trying to finish coursework. This can cause students to not get out frequently for events other than their lectures and the occasional social gathering. This has hidden consequences: less time outside walking means less vitamin D, less opportunity to make new friends, increased risk of certain diseases such as heart disease. It is imperative to emphasise to our users who do not perform enough steps in a given time period that this behaviour is not healthy. Our system will allow a user to view trends in their step data and clearly visualise how litte (or many) steps they are actually performing.

- **Tracking work done**: Students often report one of two extremes when it comes to studying: overstudying and losing out on other aspects of the student life or understudying and suffering academically. Neither of these are healthy for a student. To potentially fix this behaviour, our system should allow a user to set study goals. This allows the understudying students to have a target to achieve in a given time period, motivating them to allocate more time to study. Furthermore, this allows the overstudying students to know that they have studied a sufficient amount for a given time period and deserve a break.

- **Tracking water intake**: Water intake has many hidden benefits: helps with weight loss by making you feel more full, increases energy levels, improves skin health. Many students may neglect drinking water as they need an energy boosted via caffeinated products. By setting clear goals of how much water a user should drink, it increases the likelihood they select to drink water over a less healthy alternative.

- **Achievements and Goals**: These will be the methods by which goals for a user to achieve are set. Their main purpose is to motivate a user to change some aspect of their life. Through our research, we discovered that by providing some sort of challenge, a user becomes more motivated to complete a goal, even if no physical reward (aside from health benefits) is provided. By allowing the user to set these goals we ensure that the user finds these achievements to be possible and further increases the likelihood they change some of their bad habits. Additionally, by having system set achievements, a user may be driven to greater heights than they think they can achieve.

## 3.4 Motivating Users

Our system will allow users to set and manage goals (SRQ 7.1, 7.2, 7.3). This can be whatever a user feels is appropriate for any of the given fields including the time frame in which they wish to complete the goals. In addition to this, our system will implement achievements. This will be separate from goals and will be set by our system. For example, a goal for step count could be ”walk 10,000 steps today”. Achievements are key to our system as they provide a reason for a user to improve specific fields without aimlessly trying to increase some number (SRQ 7.4). Furthermore, these achievements rotate daily, ensuring a user never runs our of goals to achieve.

Additionally, we set additional requirements for our system to contain a range of social features (ARQ 1) including a leaderboard and groups. This was requested by many of the students we interviewed who wished to use friendly competiton as a motivator. Unfortunately, we set the priority for this requirement to low as it did not directly influence the core behaviour of our system. During the creation of our system, it was decided that this feature was too complex to implement given the time we had left to fully construct and test the system.

## 3.5 Comparing User Data

Our system must ensure a user can easily view and compare all key data fields (SRQ 5.2). This should be done through graphs displaying all fields a user selects on the same axis. This graph should dynamically change size to fit the upper bound of the data for a given user, allowing a user to easily identify any correlation between the data fields (SRQ 6.2).

The graph must allow for a user to specify a time frame (SRQ 6.2) for the data to allow such that it allows the user to identify potential outside factors that our system cannot consider. For example, an event in a given time frame such as a coursework deadline could influence sleep count.

## 3.6 Viewing and Collecting Tracking Data

Users will be given the option to synchronise their step data, both present and past from a fitbit account via the fitbit API(ARQ 2). We must ensure that potential users without the relevant hardware can still use our system and must be done in an intuitive way in order to allow our system to be accessible for a greater amount of students. This will also allow for easy gathering of data fields which cannot be tracked via physical devices (SRQ 5.1). As not all data fields we have selected can be accessed directly via the Fitbit API (sleep, and study time), manual entry is necessary (SRQ 5.3).

To ensure that our users understand what data we are storing, each user shall be allowed to view the data we have stored on them for each of these key fields(SRQ 5.2). In addition, the security of this data is paramount. We must ensure it cannot be accessed by any other end users.

## 3.7 Scalability and Performance

Scalability (ARQ 3) will not be a problem for our system as it will run entirely off of the user's computer. Additionally, in order to allow for completion of our additional requirements of adding multi-user functionality, our system must allow for easy scalability. This should be done through a well constructed database. We must ensure that this system performs smoothly and efficiently to not hinder a user's experience (ARQ 4).

## 3.8 Structuring the Software Development Process

Our development of this project must very closely follow the agile and SCRUM development approach. This will be done to ensure our system is consistently improving and changing to match what our users need. Refer to the Agile Software Process Planning and Management section for more details (covers all of SRQ 1).

## 3.9 Testing

We must extensively test each code version to ensure that our users will not run into any bugs or other issues whilst using our system. This shall be driven largely by simulating the experience an average user will have. Refer to Section 5 for more details (covers all of SRQ 4).

## 3.10 Requirements Table

| **Requirement (RQ)** | **Notation** | **Dependencies** | **Priority** |
|---|---|---|---|
| Follow SCRUM ideology | SRQ 1.1 | — | High |
| Include at least one sprint | SRQ 1.2 | 1.1, 1.3 | Medium |
| Sprints must last 1-3 weeks | SRQ 1.3 | 1.1, 1.2 | Medium |
| Review requirements regularly | SRQ 1.4 | — | High |
| Expand on initial requirements | SRQ 2.1 | 3.2 | High |
| Additional functionality for our features | SRQ 2.2 | — | High |
| Establish additional requirements | SRQ 2.3 | 2.1, 2.2 | High |
| Cite 3 articles on target field | SRQ 3.1 | — | High |
| Read and cite 6 articles | SRQ 3.2 | — | Medium |
| Testing driven approach | SRQ 4.1 | — | High |
| Provide testing evidence | SRQ 4.2 | — | High |
| Store relevant user data | SRQ 5.1 | 3.1, 3.2 | High |
| Allow users to access data | SRQ 5.2 | — | High |
| Allow for manual data entry | SRQ 5.3 | — | Medium |
| Compare user data | SRQ 6.1 | 5.1 | High |
| Allow comparison of data | SRQ 6.2 | 3.1, 3.2, 5.1 | High |
| Allow for managing of goals | SRQ 7.1 | 5.1 | High |
| Add a time aspect to goals | SRQ 7.2 | 5.1, 7.1 | Medium |
| Allow for updating of a goal | SRQ 7.3 | 7.1 | Low |
| Motivating features | SRQ 7.4 | 7.1 | Medium |
| Social features | ARQ 1 | 2.1 | High |
| Access data Via API | ARQ 2 | 2.1, 5.1 | Medium |
| Create a scalable system | ARQ 3 | 2.1 | Medium |
| System must run smoothly | ARQ 4 | 2.1 | Low |
| Easy data input | ARQ 5 | 2.1, 5.1, 5.3 | High |

Table 1: Priorities and Dependencies

# 4 Design

**TODO: Change this to something else (more intro-ish)** [In the design of our PI system, the UML diagrams serve as a cornerstone for understanding the structure and relationships within the application. The diagrams are organized to reflect the logical architecture of the system and consists of several key classes that correlate directly with the user data management and activity tracking functionalities.]

## 4.1 Database ERD Model

The Entity-Relationship Diagram (ERD) illustrates the intricate structure of our PI system, designed specifically for tracking and managing various user-centric activities. This diagram provides a visual representation of the data relationships and is critical in guiding the development process to ensure the system meets both functional and non-functional requirements effectively.

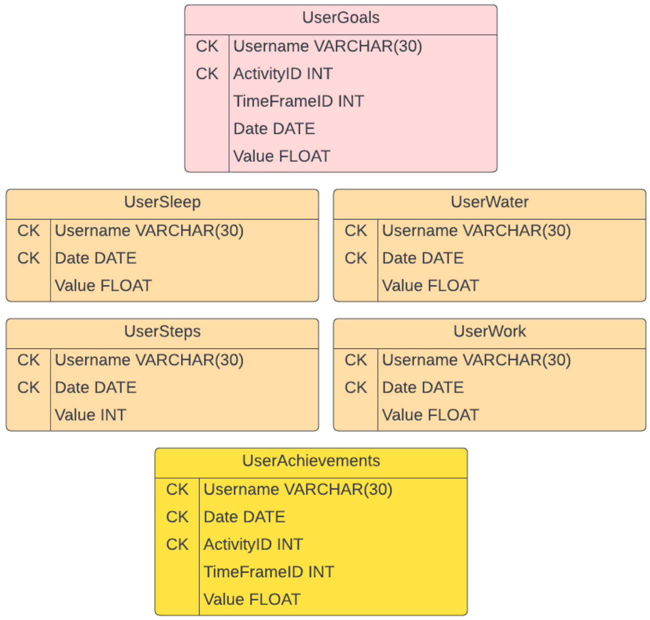



Figure 1: Database ERD model of our PI system

Figure 1 describes the following components:

- `UserAchievements` Table: This table stores specific achievements of users, linked directly to the User table. Attributes like Username, Date, ActivityID, TimeFrameID, and Value allow for detailed recording and analysis of user accomplishments across different activities and timeframes. It enables the system to provide feedback and insights based on historical achievement data, supporting motivational features such as goal setting and progress tracking. This table aimed to adhere specifically to SRQ 7.4, yet it also contributes to SRQ 7.1.

- `UserStep` Table: Dedicated to tracking the physical activity of steps taken, this class includes attributes such as Username, Date, and Value. By recording daily step counts, the UserStep table feeds into the system's health monitoring and fitness tracking capabilities, allowing users to set and monitor physical activity goals. As the data can also be inserted though an API, this table aims to cover ARQ 2.

- `UserSleep` Table: Focusing on sleep habits, this table records the duration of sleep per day for each user with attributes Username, Date, and Value. It is vital for analyzing sleep patterns and correlating them with other health metrics, which is essential for offering personalized health insights and improving user well-being.

- `UserWork` Table: This table tracks work and study sessions, an essential feature for our users. Attributes include Username, Date, and Value, facilitating the tracking of academic and work-related activities over time. This functionality supports users in managing their time and productivity more effectively.

- `UserWater` Table: Monitoring hydration, the UserWater class includes attributes such as Username, Date, and Value. Hydration tracking is crucial for overall health, and this table allows the system to remind users to stay hydrated and track their daily water intake.

- `UserGoals` Table: As a strategic component of our system, the UserGoals table holds data related to the personal objectives of users. With attributes like Username, ActivityID, TimeFrameID, Date, and Value, this table supports the setting and monitoring of personalized goals, enhancing the system's capability to drive user engagement and encourage behavior modification. UserGoals covers SRQ 7.1, 7.2 and 7.3.

`UserStep`, `UserSleep`, `UserWork` and `UserWater` are all aimed to satisfy ARQ 5 and SRQ 5.1, 5.2 and 5.3.

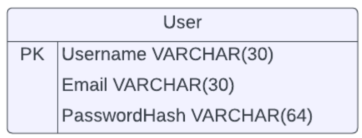



Figure 2: User Class in our database model

Figure 2 describes our `User` Table: used to be central to our system, the User table captures essential personal identifiers and account information for each user. Attributes include Username, Email, and PasswordHash, which are fundamental for ensuring secure user authentication and system access. This table acts as the primary entity with which other tables associate, establishing a one-to-many relationship across various data-tracking entities. Each instance of a User can associate with multiple records in subordinate tables, reflecting the diverse activities and metrics tracked by the system. Ultimately, the requirement for a multi-user system was omitted due to limitations in the allocated time frame. However, the underlying database architecture has been deliberately designed to facilitate the seamless integration of multi-user capabilities, should they be developed in the future. This table covers ARQ 1.

## 4.2 UML Class Diagram

We use the Dapper module on `C#` since it allows us to return or insert a list of `C#` objects from an SQL query instead of retrieving them as tuples. Hence, based on the ERD, all the classes are built for the Dapper package.**TODO: Move this paragraph somewhere else**

The class diagram of our PI system (fig. 3) delineates the fundamental components and their relationships, underscoring the system's design to efficiently manage and process user data. Central to this architecture is the Database class, which acts as the primary conduit for all data manipulation and retrieval activities within the system. This class is critical for

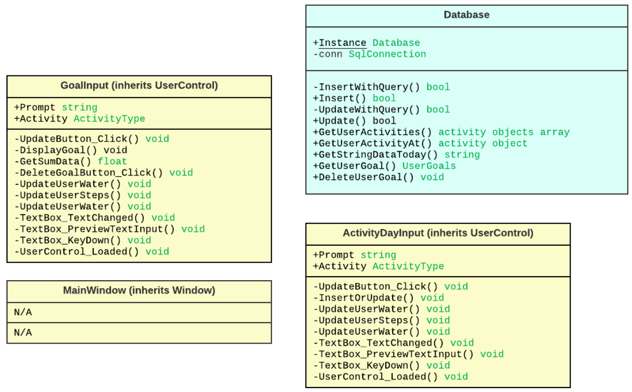



Figure 3: UML Class diagram of our PI system

the robust handling of data and supports various functionalities critical to user interaction and data integrity.

The Database class ensures a singleton pattern for database management, creating a single, globally accessible instance throughout the application lifecycle. It manages the database connectivity, facilitating secure and persistent connections to the data store. Data manipulation methods such as InsertWithQuery(), Insert(), UpdateWithQuery(), and Update() allow for efficient data insertion and updating within the database. Retrieval methods like GetUserActivities() and GetUserActivityAt() fetch activity data for users, crucial for generating reports and insights. Utility methods including GetStringDataToday(), GetUserGoal(), and DeleteUserGoal() provide additional functionality for managing daily data strings and user goals, enhancing the system's responsiveness to user interactions. These methods were essential for SRQ 6.1 and 6.2, as well as directly adhering to SRQ 5.1 and 5.2.

The ActivityDayInput and GoalInput classes, both inheriting from UserControl, are specifically designed for handling the input and update functionalities related to daily user activities and goal management, respectively. The ActivityDayInput Class includes a Prompt string for user guidance and an Activity ActivityType to specify the type of activity data being entered. It comprises various user interaction handlers such as `UpdateButton_Click()` and InsertOrUpdate() for data submission, alongside UpdateUserWater() and UpdateUserSteps() for updating specific activity metrics. Text handling methods like `TextBox_TextChanged()`, `TextBox_PreviewTextInput()`, and `TextBox_KeyDown()` ensure data integrity and user input validation.

The GoalInput Class mirrors the ActivityDayInput class in providing prompts and activity type specifications tailored towards user goals. It features goal-specific functionalities such as DisplayGoal() for visualizing set goals, GetSumData() for data aggregation, and

`DeleteGoalButton_Click()` for goal modification. It inherits text handling and initialization methods from ActivityDayInput, ensuring a consistent and user-friendly interface. Whilst ActivityDayInput stands mainly by SRQ 6.1 and 5.1, GoalInput follows SRQ 7.1, 7.2 and 7.3.

## 4.3 UML Flow Diagram

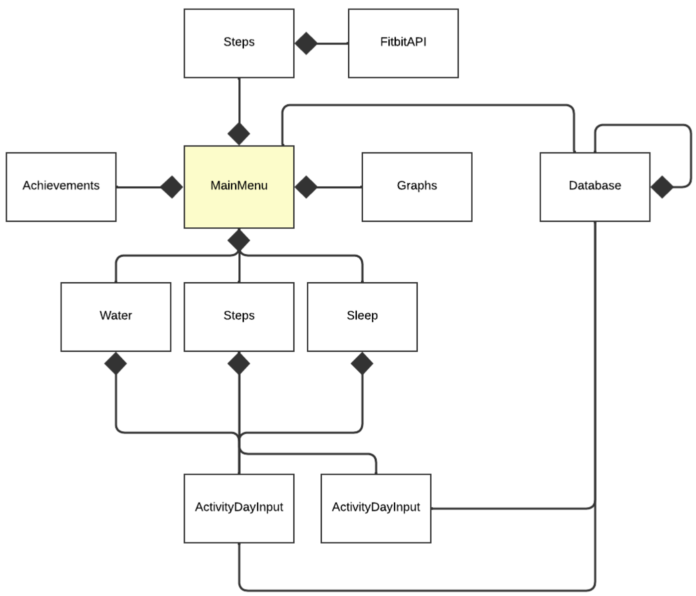



Figure 4: UML Flow diagram of our PI system

The flow diagram of our PI system (fig. 4) illustrates the interactions between classes, essential for efficient functionality and user experience. At the core is the MainMenu class, which integrates features like tracking steps, achievements, water intake, and sleep via separate classes (Step, Achievement, Water, Sleep). These classes manage specific activities and are tightly integrated with ActivityDayInput and GoalInput controls for data entry and goal management.

For example, when users input their daily water intake through the ActivityDayInput tailored for water, this control processes and validates the data, then interacts with the Water class and the Database to store this information. Similarly, the GoalInput facilitates setting and updating goals, interacting directly with the Database to ensure goals are current and reflective of user activity.

The association between the ActivityDayInput, GoalInput, and the Database ensures immediate data reflection in the system, supporting features like activity comparison and trend analysis. The Database manages its instance, maintaining data integrity and security, and acts as a centralized repository for all user data. This structure ensures seamless data flow across the system, fulfilling functional and non-functional requirements, and enhancing overall user interaction.

## 4.4 User Interface

This section outlines the design of the user interface (UI) for our PI system, focusing on creating an intuitive and engaging user experience. We aim to bridge the gap between the system's technical capabilities and the user's needs through a well-thought-out interface. The UI design is crafted to facilitate easy navigation and interaction, ensuring that users can efficiently manage and track their personal data. Here, we discuss the guiding principles of our UI design and how they enhance usability and user engagement.

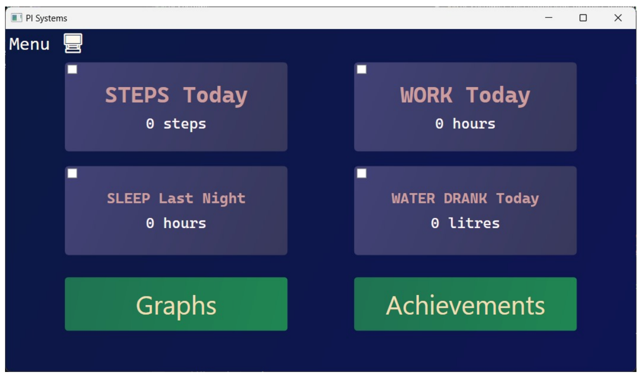



Figure 5: Main Menu of the Application

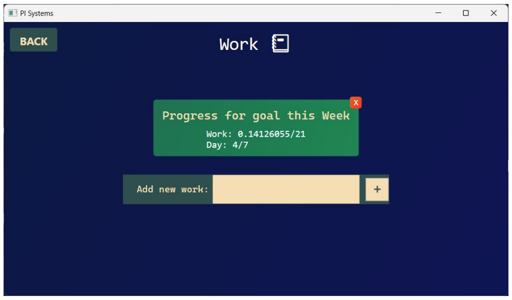
Figure 5 illustrates the main menu of our application. Positioned in the top left corner of the screen, the label `"Menu"` accompanied by a small computer icon indicates to the user that they are currently viewing the main menu. The background of the entire menu is a dark blue, a color choice designed to minimize eye strain during prolonged use of the app.

The main menu features four prominent buttons, each corresponding to the core functionalities of the Personal Informatics system: steps, work, sleep, and water. Additionally, two smaller green buttons provide access to sub-functionalities, specifically graphs and achievements. Each of the four larger buttons displays the type of statistic it relates to, with today's data (or the previous night's for sleep hours) shown in smaller font size directly below.

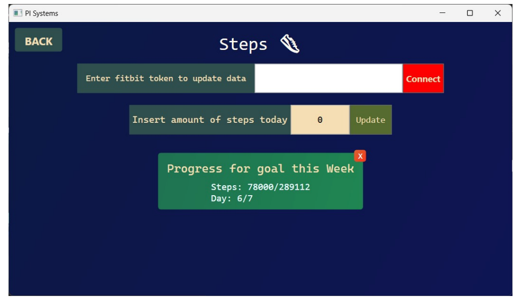
A unique aspect of the design is a small white checkbox located in the top left corner of each button. These boxes can be marked by user when they want to see the related data in graph.

Figure 6 displays the four main functionality screen, which is designed to be simpler and more focused compared to the main menu. In the top left corner, a dark green `"BACK"` button allows users to easily return to the main menu.

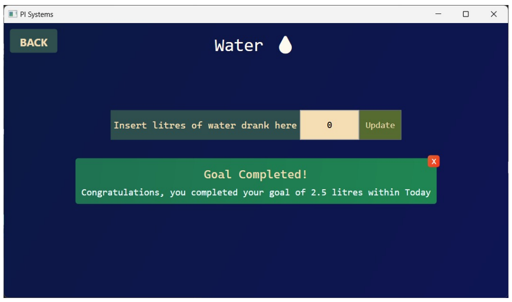
We can clearly see from figure 6a that the heading `"WORK"` is prominently displayed at the top of the screen, accompanied by a book icon to visually represent the category. Centered on the screen is a large green box that tracks and displays the user's progress on their weekly achievement goals. Under the heading `"Progress for goal this Week"` of the box, the interface shows the amount of work completed and the specific day of the week the goal was



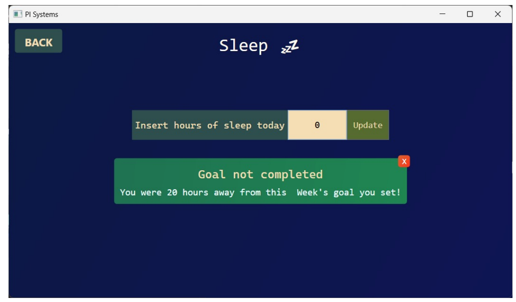

(a) Work Section Interface




(b) Steps Section Interface



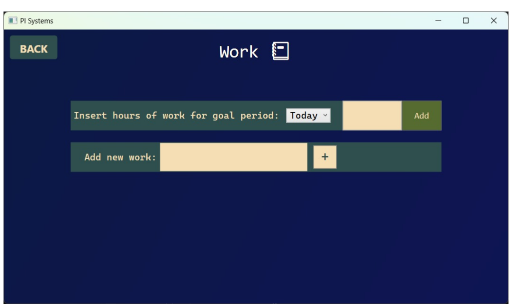

(c) Water Section Interface



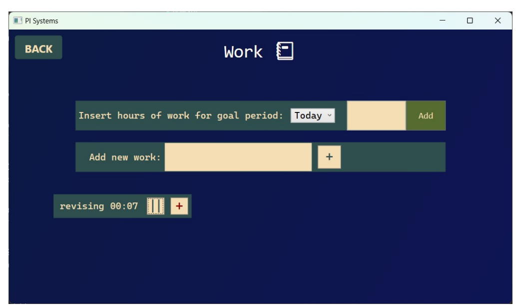

(d) Sleep Section Interface

Figure 6: Main Functionalities Interface

set. This box can be closed using the small red "x" button located at its top right corner, providing a way to dismiss the details if desired. Directly below this display, there is an input bar where users can "`Add new work`" they have completed that day. Adjacent to this bar, a plus button is the way to confirm the work users inserted and start to time it, allowing users to easily update their daily work achievements.




(a) Add Work bar




(b) Add work successfully

Figure 7: Add Work Interface

Figure 7 illustrates how the functionality Work works. When users dismiss the progress box, the will see a new input bar, which they can use to add the amount of time that they work for the time period they chose in the bar (figure 7a). Another way here is to insert the type of work users want to do in the "`Add new work`" bar and then press the plus button. The work will appear and the time start running, users can pause it whenever they like. After finishing the work, users can press the red plus button to add the time they have been working for to the progress. They can easily check it in the main menu screen.

Figure 6b presents the steps interface, which maintains a consistent design with the work screen but introduces several specific modifications. The heading `"Step"` is displayed at the top of the screen, distinguished by a shoe icon next to it, replacing the book symbol used in the work interface. A notable difference in layout is the placement of the progress box, which is positioned below the input bars rather than above. This adjustment allows for immediate and easy data entry upon accessing the screen.

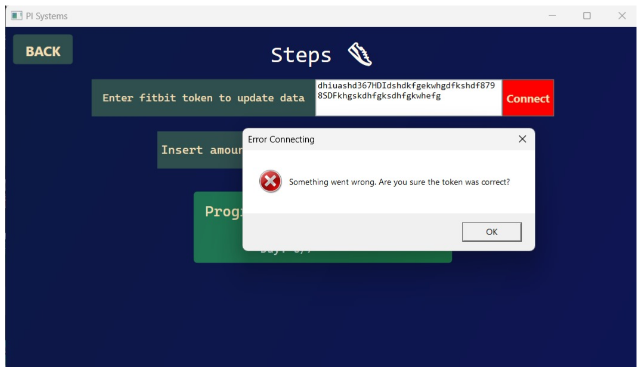



Figure 8: Error inserting wrong API Token format

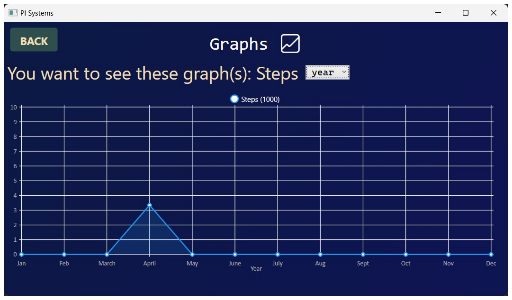
Additionally, a new input bar for inserting an API token has been added to facilitate the integration of step data from external devices or services. Directly next to the API token input bar are `"Connect"` and `"Update"` buttons. The `"Connect"` button is used for verifying the API token, while the `"Update"` button adjacent to the Step input bar enables users to refresh and submit their step count data. Any incorrect format in the input will trigger an error message, as illustrated in figure 8, ensuring users are aware of input specifications and can correct their entries accordingly.

Figures 6c and 6d illustrate the design of the Water and Sleep screens, respectively, which are consistent in layout with the other main functionalities of the app. Both screens feature a `"BACK"` button in the top left corner for easy navigation. The Water screen is identified by a heading labeled `"Water"` accompanied by a water drop icon, and the Sleep screen is marked by a heading labeled `"Sleep"` adorned with a `"zzz"` icon. Each screen includes an input bar for users to enter their respective data values easily.

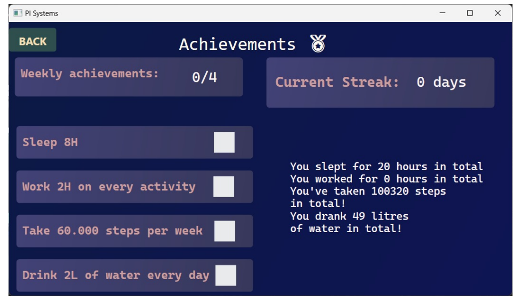
In Figure 6c, showcasing the Water functionality, the progress box is displayed upon achieving a set goal. It prominently features the message `"Goal Completed!"` in bold golden text, accompanied by a congratulatory message that also specifies the goal achieved. This positive reinforcement is designed to motivate users and acknowledge their accomplishments.

Conversely, Figure 6d details the Sleep functionality when a goal is not met. The progress box in this scenario displays a bold, golden headline `"Goal Not Completed"` at the top. Below this heading, the screen informs users of the shortfall, specifying the amount needed to achieve the goal. In the depicted example, it indicates that the user was 20 hours short of reaching the weekly sleep goal. This feedback is intended to encourage users to adjust their habits to meet their sleep targets in the future.

Figure 9a showcases the Graph interface of the application, which is designed to provide a visual representation of user data over time. The screen includes a `"BACK"` button located




(a) Graphs Section Interface




(b) Achievements Section Interface

Figure 9: Two other functionalities

at the top left corner, allowing users to easily navigate back to the main menu. The heading "Graphs", marked with a small graph icon, indicates the functionality of the interface.

The main feature of this interface is a large line graph, titled at the top to specify the type of data being displayed. Users have the flexibility to select the timeline for the graph, ranging from a day to a year, with the current example set to display data over a year. The timeline is plotted on the horizontal axis, while the specific metrics related to the user's activities are displayed along the vertical axis. The graph utilizes a light blue line on a gridded white background, enhancing readability and making it easier for users to interpret their data trends.

Figure 9b presents the Achievements interface, which aims to motivate and inform users about their progress in meeting set goals. Similar to other interfaces, it includes a "BACK" button at the top left for returning to the main menu and is labeled with the heading "Achievements", accompanied by a medal icon to symbolize success and recognition.

The interface is divided into two main sections. On the left, a box at the top displays the number of achievements completed within the week, indicated as "0/4" in this example, suggesting no goals have been met yet. Below this summary, four boxes represent the achievements tied to the four main functionalities of the system (steps, work, sleep, and water). Each box includes a white checkbox that is ticked off when the corresponding daily goal is achieved.

On the right half of the screen, a white text box provides a summary of the total activities completed for each functionality during the week, assisting users in tracking their weekly progress. Additionally, a streak counter is placed above the activity summaries, encouraging users to consistently meet their daily goals and build long-term habits.

Together, these interfaces support the app's objective to engage users actively in tracking their progress and achieving their health and productivity goals.

# 5 Software Testing and Verification

During the initial planning of this project, the approach to testing was discussed. It was agreed that each time a developer completed a feature from the product backlog they would thoroughly white-box test it themselves using a variety of specifically chosen test cases and take screenshots to record the results. If all tests produced the desired results, the developer would consider the feature complete. If any tests were unsuccessful, however, they would debug and fix the problem before applying all tests again. In this way, the component's functionality given both valid and invalid inputs would be ensured. By testing each element before combining it with other elements of the system, the testing process as a whole would comprise a bottom-up integration testing approach. On the completion of a part of the product backlog, the developer would send the screenshots produced in testing to the product owner. The product owner would then analyse the screenshots to ensure that the evidenced functionality aligned with the requirements of the product backlog. The product owner would also use the screenshots to provide feedback to the developers and to inform future decisions and alterations to the product backlog.

### 5.1 Example

Below is the outcome of the testing of the ——— feature:

## 6 Reflection and Conclusion

With our PI system now complete and the specified requirements met, we can reflect on the merits and failures of the system and our approach to it. To do this we will critically analyse the way our system was designed and specified, as well as the approach we followed during development. By doing this we will be able to conclude as to the success of this project as a whole, consider future alterations to our system and analyse ways in which our approach could be improved. Learning from this, we will be able to develop systems more successfully in the future. Unfortunately, due to the deadline for the completion of our project, we will not be able to try using our system for a significant period of time in order to properly gauge how well it works from a user's perspective but, we can still evaluate it from a critical viewpoint and make educated speculations about its effectiveness.

### 6.1 System Development

The creation the specification for our system began with research to establish the interests of our target demographic. The biggest parts of this research were an online form distributed to our peers and some interviews. The results of these were very helpful and were the driving force behind our choice of tracking metrics. However, while this approach was sound and successful in gathering information, only around twenty individuals filled in the form and we only managed to interview two individuals. This is a large enough number of people that we feel comfortable with using the results as a guide, especially given the clear majority in the opinions of the form respondents. However, in future, ensuring a larger sample size would improve the reliability of our results and, at the very least, make us more certain in our decisions.

Our choice of tracking metrics was informed both by data gathering and by research into other PI systems. This meant that our final list of four metrics reflected the desires of our peers, as well as our informed opinions on the most beneficial choices. On reflection, these four metrics still seem to provide an excellent and balanced summary of an individual's physical and mental health in a way that appears likely to provide useful insights and achievable targets. We are therefore confident that our choice of metrics is sound. However, due to the variety of research responses, especially from the interviewees, it was not possible to take the views of every individual into account; there were a few features suggested during the interviews which were not added to the specification, either due to the need to limit the scope of the system or because they didn't align with the conclusions of other respondents or with our research. In future, looking back on this research or through conducting more thorough research, we could implement extra features over a longer period if a consensus was reached among requests.

One key requirement we specified for our system, which is a very important feature of any PI system, was the ability to log data. This specification was clearly met, with the user able to log their progress in all four metrics. The manual data entry process is also very simple and intuitive, with very little room for confusion. By implementing it in this way we have made the data entry aspect of our PI system as effortless as possible, thereby making the use of our system more pleasant for the user. The system also has the ability to use the Fitbit API to gather data, as specified in the requirements. While this does work well and fulfils the requirements, Fitbit refresh API tokens on a regular basis. This means that users are regularly required to re-enter their Fitbit API token for our system to gather their data, reducing the benefits of the automated tracking. In future, it would be beneficial to look into avoiding this problem so that the effort required on the part of the user is minimised. Avoiding this is presumably possible as the Fitbit mobile app is reportedly built using this API and does not require repeated token entry from users.

Another important PI feature which our specification detailed was the intuitive display of user data and progress. This requirement was successfully met through the use of a software library specialising in graphs. Using this, aesthetic, interactive and detailed graphs for chosen metrics were produced, giving users insight into health variations in their lifestyle. A possible area for improvement in this section would be the highlighting of particularly healthy periods of time to motivate the user, as this has been shown to promote positive reflection (Loerakker et al., 2023). However, the functionality of this feature certainly meets the requirements we set out.

The principal other feature our specification required was the inclusion of goals and achievements. This was also successfully implemented and provides an effective way to track progress towards goals and to provide motivation, making it a worthwhile part of the specification and the system. In future, however, a possible improvement would be the ability to see other users' achievements within the application. Of course, successes can be compared by the sharing of screenshots or in-person demonstration but a built-in system would make this easier and could help spread word of the system to more students who might find it useful. Additionally, the ability to have multiple goals per activity could be beneficial for some users. For example those who would like to have a short-term goal and a longer term goal.

The database our system uses is designed to integrate intuitively with the structure of our software and is quick and easy to understand and access. The addition of future metrics to our system would not be difficult to implement, simply requiring an associated table. However, while our database is intuitive, it could be normalised further by adding a bridging table with activity IDs. The benefit of this change would be increased efficiency and ease of further development. Adding new metrics would likely only require an extra record in the Activities table. However, there would also be downsides to this approach; understanding the layout of the database would be less simple, relying on keeping track of foreign keys and more complicated database queries. Our class design closely resembles that of our database and is therefore similarly intuitive. If we were to alter the database design, careful alterations to the interface between the database and the code could maintain the clarity of data storage from a programming perspective by minimising changes in the class design.

As per our specification, the PI system is a locally-run PC application. This is beneficial to users when it comes to the viewing of the graphical statistics provided by the program as the majority of computers running the program will likely have a larger screen than a tablet or smartphone. However, it also requires that users log data using a large device. This could become quite burdensome, especially when away from home, because of the requirement for a laptop running the system. Given the widespread use of smartphones which are often carried almost everywhere, a future improvement to our system would be to allow the tracking of data on mobile devices, making the process much more portable and accessible.

Our approach to the test-driven development of our system worked well in practice, with developers finding most of the bugs in their own code during testing and the finished product working effectively with no known issues. By using white-box testing the developers were able to apply tests based on their in-depth knowledge of the processes involved, thereby anticipating problems others would not. However, on one occasion, a bug went unnoticed by the initial testing and was only picked up by the product owner. This implies that, in future, a combination of white-box and black-box testing might prove to be more robust due to the diverse perspectives provided by group work.

## 6.2 Software Process

To develop this product we followed the Scrum framework and the Agile methodology of software development with the aim of allowing us to structure and manage the creation of the system in an effective and methodical way. We managed to complete five week-long sprints during the development process with the sprint backlog successfully cleared during the majority of the sprints and almost cleared during the rest. This process definitely helped us to keep track of our progress in comparison with the specification and kept us to an efficient schedule which kept development moving at a sensible pace. It also allowed the system requirements to evolve during development, leading to a better final product overall.

One way in which we could have improved our adherence to the Scrum framework would have been the inclusion of more frequent Scrum meetings. During our sprints, frequent Scrum meetings were held to discuss progress but they did not always occur on a daily basis. Holding daily scrum meetings would have been impossible given our busy and clashing schedules, especially during the Easter Break when developers had significant plans outside of work. However, more Scrum meetings could have been held on occasion and may have improved communication and understanding within the group.

A notable way the Agile methodology allowed us to evolve our requirements was in the design of the system's database. In a sprint planning session part way through the development process, it was realised that our database could be made more efficient by adjusting the design. The product backlog was updated to include this new design and the change was implemented as part of the sprint that followed, making the database more efficient. In this way, the Agile methodology helped us avoid future problems and work by allowing flexibility during the development process

A part of the process that worked particularly efficiently in our group was the sprint planning weekly meetings. By having a member of the team run the meetings, and through open communication, we managed to always ensure that every member of the team had something to do and could work on them effectively during the sprint so that the group as a whole produced meaningful results during the sprint and finished the project before the deadline.

## 6.3 Conclusion

In conclusion, through carefully considered design and adherence to Agile methods, we managed to successfully produce a working PI system in an organised way. We believe that this system is intuitive, informative and robust. Furthermore, our approach to testing and development was effective, however testing may have been improved by incorporating a more collaborative system. Therefore, the development of this system has primarily been a success. However, there are areas in which the system itself could be improved in future to increase ease of use, which given a longer development time could have been addressed accordingly.

# 7 References

[1] Jones, S. L. and Kelly, R., 2018. Dealing With Information Overload in Multifaceted Personal Informatics Systems. *Human–computer interaction*, 33(1), pp. 1–48. https://doi.org/10.1080/07370024.2017.1302334

[2] Kersten-van Dijk, E. T., Westerink, J. H. D. M., Beute, F. and IJsselsteijn, W. A., 2017. Personal Informatics, Self-Insight, and Behavior Change: A Critical Review of Current Literature. *Human–computer interaction*, 32(5–6), pp. 268–296.

[3] Potapov, K., Vasalou, A., Lee, V. and Marshall, P., 2021. What do Teens Make of Personal Informatics? Young People's Responses to Self-Tracking Practices for Self-Determined Motives. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 8-13 May 2021, New York. Association for Computing Machinery, pp. 1–10.

[4] Loerakker, M.B., Niess, J., Bentvelzen, M. and Woźniak, P.W., 2023. Designing Data Visualisations for Self-Compassion in Personal Informatics. *Proceedings of the ACM on interactive, mobile, wearable and ubiquitous technologies*, 7(4), pp. 1–22.

[5] Madore, K. P. and Wagner, A. D., 2019. Multicosts of Multitasking. *Cerebrum:the dana forum on brain science*[Online], 4(19). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7075496/#sec-a.c.ftitle [Accessed 5 April 2024]

[6] National Health Service, 2023. *Water, drinks and hydration* [Online] Available from: https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/water-drinks-nutrition [Accessed 5 April 2024]

[7] Rapp, A. and Cena, F., 2016. Personal informatics for everyday life: How users without prior self-tracking experience engage with personal data. *International journal of human-computer studies*, 94, pp. 1-17

[8] Tudor-Locke, C., Craig, C. L., Brown, W. J., Clemes, S. A., De Cocker, K., Giles-Corti, B., Hatano, Y., Inoue, S., Matsudo, S. M., Mutrie, N., Oppert, J. M., Rowe, D. A., Schmidt, M. D., Schofield, G. M., Spence, J. C., Teixeira, P. J., Tully, M. A. and Blair, S. N., 2011. How many steps/day are enough? For adults. *The international journal of behavioral nutrition and physical activity* [Online], 8(79). Available from: https://doi.org/10.1186/1479-5868-8-79

[9] Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F. and Tasali, E., 2015. Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep*, 38(6), pp.843–844.

# 8 Appendices

## 8.1 Group Contribution Form

| Name | Email | Contribution | Comment |
|---|---|---|---|
| **Akim** | ak3625 | 10 | Led meetings, essentially managed the whole project and was constantly giving feedback |
| **Alex** | ah3208 | 8 | Good group member who fully participated |
| **James** | js4209 | 8 | Good group member who fully participated |
| **Jeet** | jm3522 | 10 | Took on most of the technical element of the project and was always working on the program |
| **Katrya** | kd794 | 8 | Good group member who fully participated |
| **Martin** | md2353 | 8 | Good group member who fully participated |
| **Ollie** | ov247 | 8 | Good group member who fully participated |
| **Tom** | tb2301 | 8 | Good group member who fully participated |
| **Thang** | ctn32 | 8 | Good group member who fully participated |

## 8.2 Contribution Table

| **Name** | **Week 1** | **Week 2** | **Week 3** | **Week 4** | **Week 5** |
|---|---|---|---|---|---|
| **Akim** | Led meeting, took down minutes, created Github Repo, created latex report framework and created and ran a survey | Led meeting, took down minutes, assigned workload, created UI diagram and presented to the Technical Team | Led meeting, took down minutes, assigned workload and reviewed the documentation | Led meeting, took down minutes, assigned workload and reviewed the documentation | Led meeting, took down minutes, assigned workload and reviewed and improved the documentation |
| **Alex** | Researched PI structures, found out what data to collect and researched the effective of PI systems | Created UI diagram with Akim | Attempted to work on UI | Documented the functional requirements and justifications for each | Adding requirements to the Design section |
| **James** | Reviewed, commented and created priorities to each given requirement and added some additional ones | Worked on Steps and Work UI and added some functionality | Added more functionality to the work page e.g. timers | Added ability to delete work goals and all work done adds to a total work value | Reviewed and provided feedback on the report |
| **Jeet** | Interviewed people about PI systems and created transcript about key data gathered | Made database ERD, UML class diagrams, researched SCRUM and finished Menu UI | Updated the way databases work and created goal table that works with the UI | Connected Fitbit API with the app, where the user can input their token to download all their data | Made a Work table that works with James' UI and added some functionality to the update button |
| **Katrya** | Made table comparing appropriate languages for the UI design | Researched databases and C# connections | N/A | Created achievements UI and functionality | Polished up achievements UI |

| | | | | | |
|---|---|---|---|---|---|
| **Martin** | Made summary on research into Fitbit software | Wrote Introduction section | Wrote Agile software section of report | Started Testing section and updated Agile section | Wrote reflection, conclusion sections and updated Agile section |
| **Ollie** | Made summary on two articles on PI systems | Created the UI, made theme and researched graphing | Applied graphs to the UI with each statistic | Connected graphs to database and added the ability to change time period | Screenshotted prototype 1, integrated work into graphs and polished graphs UI |
| **Tom** | Made summary on research into Garmin software | Created basic program showing how Fitbit API could be used | Rephrased specification section and added more detail to documentation | More rephrasing in specification section, finished non-functional requirements and polished other parts | Updated specification section to reflect our program, requirements table |
| **Thang** | Made summary on two articles on PI systems | Wrote first half of specification section and drafted second | Started writing design section and finished ERD description | Completed design description with UML models and added non-functional requirement justifications | Adjusted UML description and finished UI design description |