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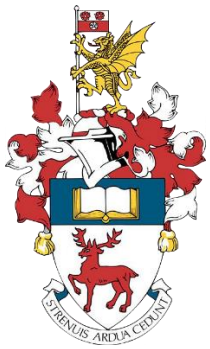

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April 23rd, 2021

Exploring the Potential of Digital Behavioural Interventions in Alleviating the Imposter Phenomenon

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Abstract

The Imposter Phenomenon (IP) is a widely experienced phenomenon which is becoming more relevant every day as society progresses and study and work environments become more challenging. While not considered a mental disorder, IP does lead to depression and anxiety, and may lead individuals to lose morale in pursuing any form of self-progress.

This project intends to explore the potential Digital Behavioural Interventions (DBIs) may have on alleviating experiences of the Imposter Phenomenon individuals might experience. To gain insight on the potential of DBIs, an Android application was developed across several steps.

First, key behaviours that sustain the Imposter Phenomenon have been identified, and an intervention plan was created guided by the Persuasive Systems Design and several treatments for IP found in literature. This intervention plan was then digitised, developed, tested, and finally evaluated across several aspects, including functionality, usability, engagement, imparting familiarity of IP, and effectiveness in alleviating feelings of IP.

The results of the evaluation seem to indicate the application meets several success benchmarks, despite some minor issues. And the overall outcome offered insight into the tangible potential DBIs could have on alleviating feelings of IP within individuals, thereby successfully meeting the goals of this individual project.

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1 Project Description

1.1 Problem

As society grows to become more challenging and demanding, The Imposter Phenomenon (IP) is becoming more and more relevant and relatable, with an estimate that 70% of all people will experience IP at a certain point in their lives [3].

The Imposter Phenomenon, put simply, is the phenomenon that manifests when an individual is unable to internalise their success, and feels that their achievements are fraudulent and undeserved [1]. If left untreated, prolonged exposure to IP leads an individual to experience clinical levels of depression or anxiety that they might be discovered or “outed” as an imposter [2].

On a larger scale, IP has been proven to impact students, faculty, and employees in professional environments, with its effects increasingly more prevalent as higher education and workplaces become more challenging and competitive [6].

Given the severity of IP, various treatments have been developed to limit its effects. Most of which rely on therapy and guidance counselling. An opportunity exists to explore whether technology could be used to aid or assist in these treatments, either by digitising aspects of the treatment plan, or offering a supportive tool for therapists and counsellors to recommend.

1.2 Goals

The goal of this individual project is to explore whether Digital Behavioural Interventions (DBIs) could be viable in alleviating experiences of the Imposter Phenomenon within individuals.

To gain insight into the potential of DBIs, a DBI in the form of an Android application which aims to alter key behaviours that sustain the Imposter Phenomenon will be designed, developed, tested, and evaluated across several aspects, determining its functionality, usability, engagement, success in imparting familiarity with IP, and effectiveness in alleviating the key behaviours and feelings of Imposter Phenomenon within an individual.

1.3 Scope

In this project, I will be incorporating a Digital Behavioural Intervention Model known as the Persuasive Systems Design model along with several IP treatment plans into an Android application. This application will administer an intervention plan altering key behaviours that sustain the Imposter Phenomenon. The application will be aimed at individuals identified to be experiencing characteristics of the Imposter Phenomenon.

2 Background Research

2.1 The Imposter Phenomenon, its Reasons, Effects, and Characteristics

As mentioned, an estimated 70% of all people will experience the Imposter Phenomenon at a certain point in their lives. It can affect a wide range of people of all genders, backgrounds, and occupations [3]. Various research has gone into the possible causes of IP and the notable rise of cases in recent decades. The most recognised factors are attributed to be due to an individual's perfectionism and family environment during formative years [4].

While IP is not considered a mental illness, as it is not listed in the Diagnostic and Statistical Manual [5], and while not being directly self-destructive, it does affect an individual's psychological well-being and, if left untreated, has shown to lead to clinical levels of depression or anxiety. Beyond that, the Imposter Phenomenon may lead an individual to give up attempts at succeeding and to seriously hinder their goals and aspirations [1].

The Imposter Phenomenon Characteristics

In her book, "The Imposter Phenomenon: Overcoming the Fear That Haunts Your Success", Clance describes IP in detail and identifies several of its characteristics as being:

1) The Imposter Cycle: This consists of the individual facing a task or a goal which they would initially fear. After completion of the task, the individual's inability to internalise success and discount praise would further fuel future fears and anxieties, thus repeating the cycle.

2) The need to be special and the very best

3) Superwoman/Superman aspects: refers to perfectionism, which manifests in individuals through setting unrealistic goals and tasks and expecting a perfect performance every time.

4) Fear of failure

5) Fear and guilt about success

6) Denial of competence and discounting praise.

These characteristics vary from person to person. And while a person may not exhibit all these characteristics, exhibiting at least two would classify an individual as experiencing IP [7].

2.2 Measuring and treating the Imposter Phenomenon

2.2.1 Measuring IP with Clance's IP Scale:

At first, the Imposter Phenomenon was identified in individuals using descriptive attributes [8]. Later research sought to standardise this process through developing scales designed to measure the severity of the Imposter Phenomenon an individual would experience; the most prominent scale being the Clance IP Scale (CIPs). Which was designed by Clance and has proven to reliably identify individuals who experience IP [9].

2.2.2 Imposter Phenomenon Treatment Plans

Due to the increasingly adverse effects IP has on an individual, several treatments have been created. Treatments range from those that address the causes that might lead an individual to start experiencing IP, to treatments that target the actual characteristics an individual might exhibit which would exacerbate the effects of IP [10].

While no "fixed" treatment plan for IP exists, several strategies and techniques have been identified in the literature, including:

1) Recognise, understand, and normalise IP, its effects, causes, and behaviours [11][12][13].
2) Embrace a growth mindset by focusing on every possible gain from your actions, rather than obsessing over losses [13].
3) Accept recognition over personal accomplishments [11][12].
4) Understand perfectionism and endorse a more realistic approach to goals and results [12].

2.3 Digital Behavioural Interventions

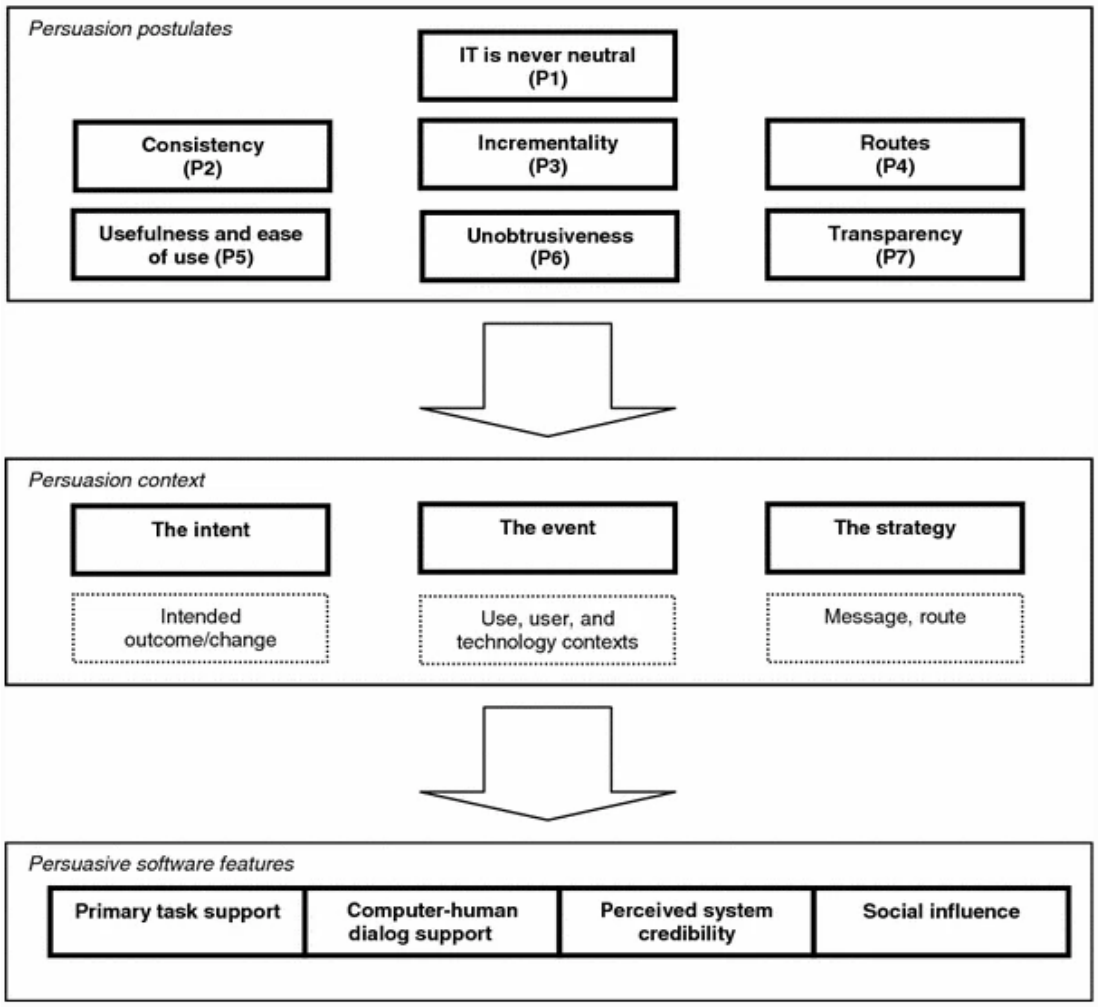
Behavioural Interventions (or Behavioural Change Interventions) are "Coordinated sets of activities designed to change specified behaviour patterns" [14]. In other words, it is a plan to interrupt, or intercept certain behaviours in individuals that are negative to their health.

Digital Behavioural Intervention (DBI) is defined as "an intervention that employs digital technology to promote and maintain health, through primary or secondary prevention and management of health problems" and through "supporting behaviour change" [15].

Or simply; Behavioural interventions delivered through a digital medium.

2.4 Oinas-Kukkonen's "Persuasive System Design" Framework

A prominent DBI framework researched was Oinas-Kukkonen's "Persuasive Systems Design" (PSD) framework, which is presented as such:



(figure 2.1: Persuasive Systems Design Framework Pipeline)

PSD first offers postulations (suggestions) which clarify and offer a deeper understanding of persuasion, and therefore maximise the effectiveness of the intervention plan.

Following that, the model dictates methods to carefully analyse the persuasion context through defining an intent, an event, and a strategy of persuasion. The intent is explored through defining the desired outcome and type of change. The event is then clearly stated by identifying the use, user, and technological contexts of the treatment plan. And the strategy is mapped out by defining the treatment plan and the route of delivery to the users.

The Persuasive Systems Design Framework then defines four categories of software features in which the previous components can be easily translated into a digital medium [16].

2.5 Other Relevant Research

2.5.1 Effective Engagement

A critical aspect to consider when designing a Behavioural Intervention plan is the individual's engagement with the intervention. Due to the lack of human support, this can prove notably difficult when administering a BI through a digital medium [17].

Smartphone applications offer various techniques to potentially improve an individual's engagement with a created intervention plan, through allowing on-the-go access to the plan and registering possible changes and inputs.

In addition, various studies have shown that using smartphones has led to greater engagement with past behavioural interventions, which in turn led to notable results in achieving the desired behavioural change[18][19].

2.5.2 Goal Setting Theory and Reflection

Locke and Latham introduced a well-developed theory of goal setting which investigates the relationship between goals and performance, and sought to maximise an individual's motivation, therefore leading to a higher performance output [20].

As a result of their research, Locke and Latham listed five principles to consider when setting a goal [21], as such:

Principle	**Details**
Clarity	Clear goals ensure the individual understands what they are trying to achieve, allows measuring results accurately, and identifying behaviours to reward.
Challenge	People are often motivated by challenging goals. However, it is vital to set realistic goals that are achievable.
Commitment	The individual must be committed to the completing the goal. Therefore, any goal must have good reasons for being set. This can be done by ensuring the goal matches the individual's values and ambitions.
Feedback	Receiving feedback is vital for goal setting. This does not necessarily have to be from a peer or a supervisor but can be through proper reflection on goals. In this case, however, extra measures must be taken to ensure reflection does not sustain negative behaviours.
Task complexity	Goals must not be too large and complex but must be broken down into manageable tasks.

(figure 2.2: Goal Setting Theory Principles)

Building a reflective mindset through repeatedly reflecting on completed goals aids individuals in seeing patterns and areas of potential improvement, as well as regarding failure as opportunity for growth [22].

Background Research

Goal Setting theory, coupled with proper reflection allows, an individual to attain a growth mindset, properly acknowledge their achievements, and avoid perfectionistic tendencies, all of which will be essential to the created intervention plan.

3 Methodology

The goal of this project is to gain insight into the potential Digital Behaviour Interventions (DBIs) might have in addressing the Imposter Phenomenon (IP). The background research and literature review have helped to understand both the Imposter Phenomenon and the characteristics through which it might manifest within an individual, as well as the concept of Digital Behavioural Interventions, and identified the Persuasive Systems Design framework (PSD) as a prominent framework used to create DBIs.

The background research also identified smartphone applications as an efficient and engaging medium to deliver a DBI plan. In addition, developing and testing a smartphone application is a feasible approach given the various resources that are available to students. Evaluation would also be feasible and straightforward in the form of a usability study administered to the users through their smartphones.

Given the reasons above, the decision was made to design and present a DBI through **a smartphone application prototype**. This prototype would incorporate techniques and methods from PSD and the several IP treatment plans researched. The goal of this prototype would be to deliver an intervention plan that addresses key behaviours that have been identified to sustain Imposter characteristics within an individual.

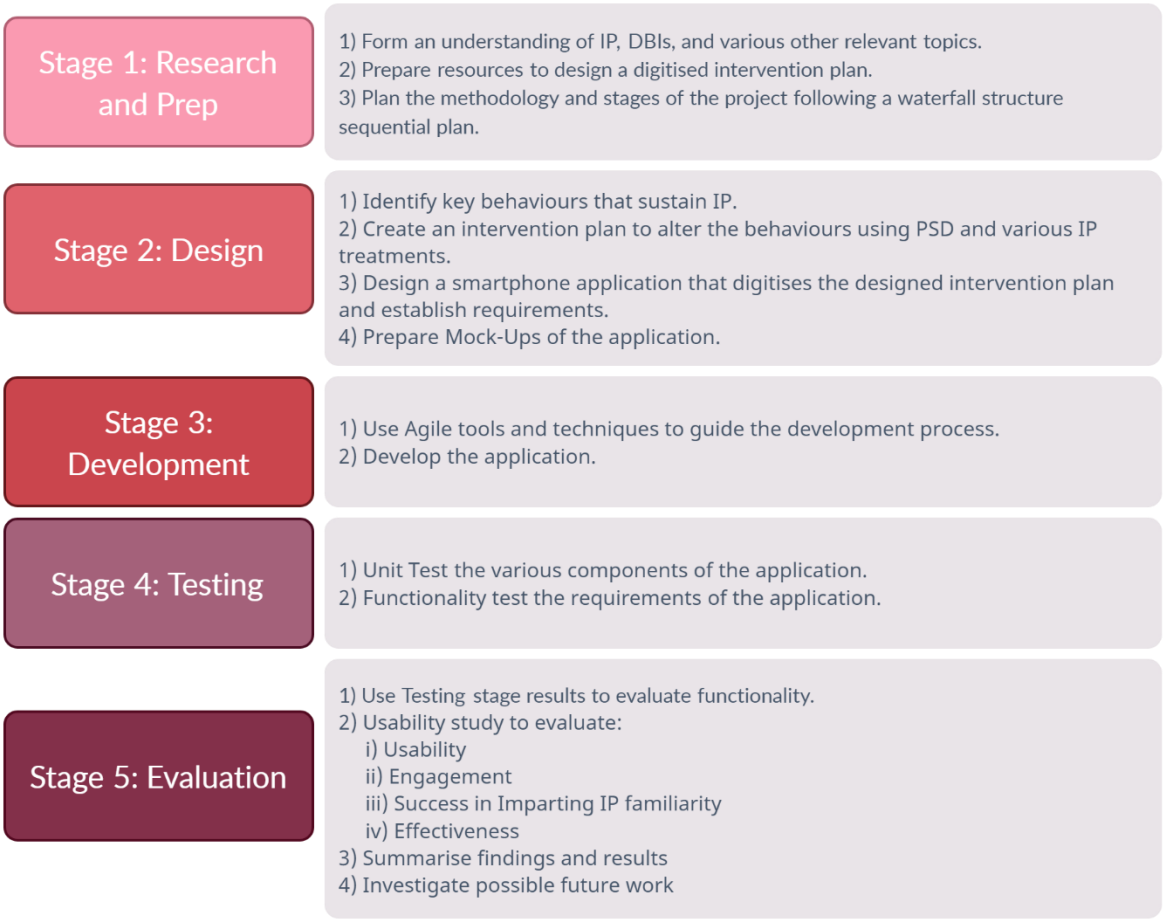
Through designing, developing, testing, and evaluating the application, valuable insight would be gained into the potential DBIs might have in lessening feelings of IP, and therefore achieving the project's goals.

3.1 Sequential Stages Plan

To properly develop the prototype to be suitable for the goals of this project, several steps were required: First, key behaviours that sustain IP were identified, then an intervention plan targeting these behaviours was created. This intervention plan was then digitised, and an application designed. The application was then developed, tested, and evaluated.

These steps were sequenced following a waterfall approach. While following the Agile methodology was considered, ultimately waterfall was decided on as the scope, goals, and deliverables were pre-defined and the sequences of the stages were essential as each stage informs the next stage, making an iterative approach detrimental [23].

The steps mentioned above have been compiled together into a project pipeline as such (figure 3.1), followed by a brief breakdown of each step:



(figure 3.1: Individual Project Sequential Stages)

3.1.1 Stage 2: Design Stage

In this stage, the initial step was to identify key behaviours that sustain IP within an individual. This was done through a study containing a survey which was accessible through iSurvey and targeted students of the university. The participants were asked to respond to a digitised Clance IP scale (CIPs), the results of which were analysed so as to identify key behaviours were successfully identified.

Following the study, an intervention plan to alter these behaviours was created primarily guided by the Persuasive Systems Design (PSD) framework and informed by several researched treatments for IP discovered during the background research.

This created intervention plan was then digitised and clear requirements for an application (titled “Imposterless”) were gathered. Finally, mock-ups of the prototype application in the form of low-fidelity wireframes were created through Balsamiq [www.Balsamiq.com].

3.1.2 Stage 3: Development Stage

While the project itself followed a waterfall structure, the development stage was guided by an Agile approach. This was mainly due to Agile's iterative approach, various tools, and techniques being beneficial in guiding the development process.

As such, user stories, product backlog, burndown chart, and a sprint plan were created from the requirements gathered. Trello [www.Trello.com] was used to manage the sprints and an excel template was used to track the burndown chart.

3.1.3 Stage 4: Testing Stage

Following the completion of the development stage, the application was subjected to both unit and functionality testing.

Unit testing was conducted using Junit tests in Android studio, and targeted various smaller units within the system. While functionality testing was conducted using several virtual Android machines available through Android Studio, and targeted the various outlined requirements gathered in the design stage.

3.1.4 Stage 5: Evaluation Stage

To fully explore the potential of DBIs and whether the developed prototype fulfils the goal of the project, several aspects were evaluated, including functionality, usability, engagement, success in imparting familiarity of IP, and effectiveness.

A large part of the evaluation was conducted through a usability study which was carried out through contacting participants from a previous study to detect the key behaviours to target.

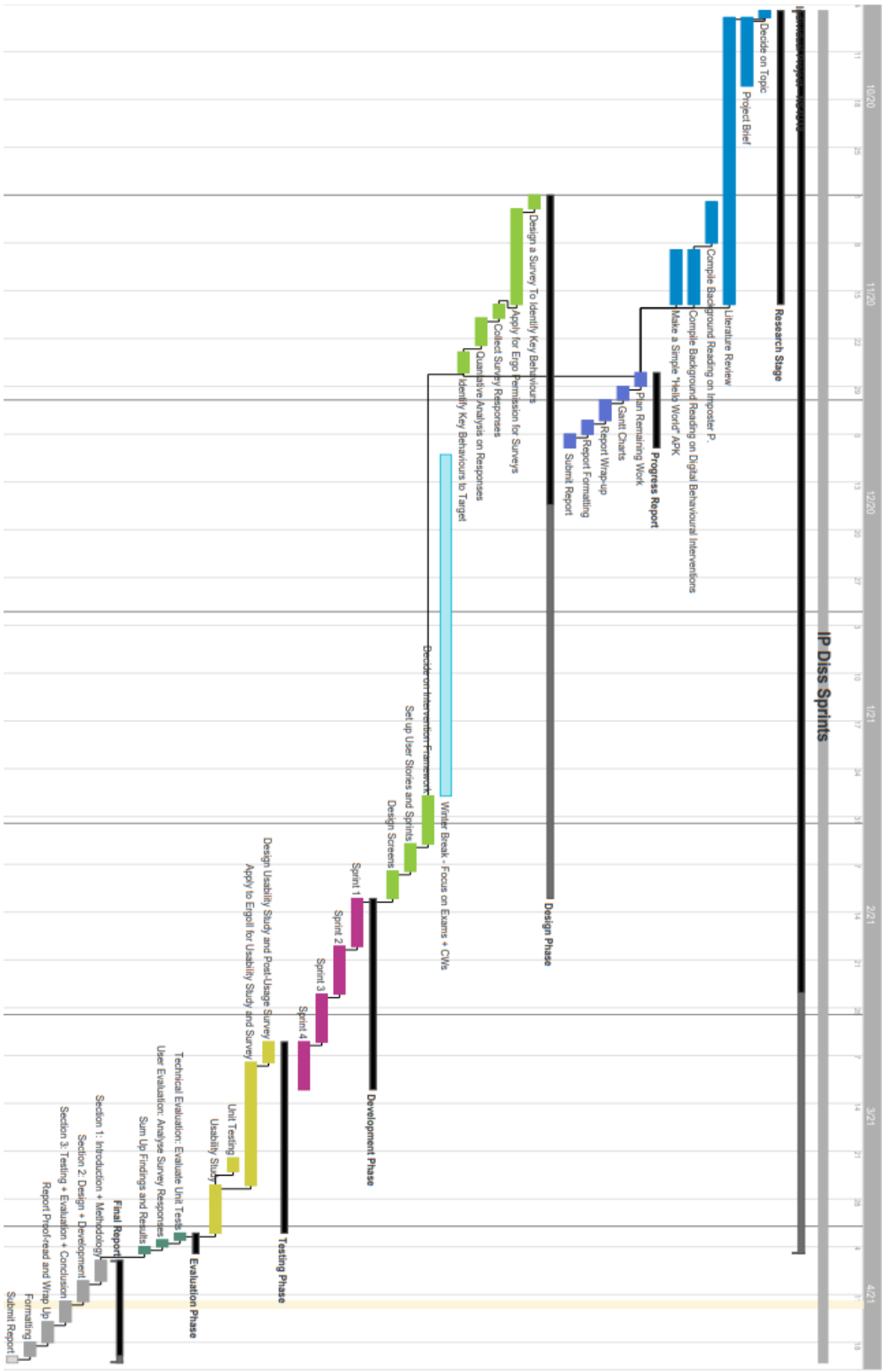
The usability study consisted of two parts: the first asking the users to complete a set of tasks, and the second asking the users to use the application in a normal, unmoderated setting for a week.

The study enlisted 8 participants, which were asked to complete a pre-study and post-study survey administered through the university's iSurvey. These survey responses were then analysed, and the results were evaluated.

3.2 Project Management

3.2.1 Project Gantt and Schedule

After deciding on the sequential stages of the methodology, a Gantt chart was developed towards the end of the first semester. This Gantt chart helped schedule the various stages across the year, verifying the workload to be properly distributed, and ensuring project efforts remained on track. The initial project chart is as follows:



(figure 3.2: Initial Gantt Chart)

(**A larger version of the Initial Gantt Chart has been appended, split by semesters** [**Appendix 1**](#))

3.2.2 Chart Changes and Modifications

As the project progressed and ideas developed, the initial Gantt chart evolved to accommodate changes. Most notably, an extra week has been added to the development stage as sprint 5. This sprint was necessary to ensure appropriate content was added to the application. In addition, functional testing was added as an extra stage to testing.

These additions were accounted for by reducing the time allotments for the evaluation and final report stage through logging decisions and progress and preparing draft writings throughout the project, therefore significantly reducing the time needed to write the final report.

(A Gantt chart of the final project plan has been appended: Appendix 2)

3.2.3 Project Planning Impediments

A notable impediment to the progress of the project were issues with the ErgoII Ethics application required to conduct the usability study, which is essential for evaluation. Although the application was submitted as planned two weeks before the usability study was required, permission to initiate the study was given two weeks after the expected outcome and the planned start of the study.

This possibility was considered in the risk analysis below (item 3), with a proposed solution to "Reorganise the backlog and complete tasks that are not reliant on the usability study application (such as the Technical Evaluation and writing sections of the final report)". However, this solution proved to not be necessary as a new ECS policy was instated [https://secure.ecs.soton.ac.uk/notes/comp3200/ethics/] which offered blanket ethics approval that covered the usability study proposed, and the project progressed as scheduled.

3.2.4 Risk Assessment

A risk analysis was conducted at the end of the research and prep stage to account for possible occurrences that could have affected the project outcome or the schedule of the work:

Item	Risk	Probability (1: Low, 5: High)	Severity (1: Low, 5: High)	Exposure (P*S)	Action
1	Laptop/Laptop Storage Damage	1	5	5	Multiple synced backups of all project materials (Reports, findings and code) across both GitHub and University OneDrive
2	Falling ill / Contracting Covid-19	2	4	8	Allot tasks with comfortable windows and leave unallotted time towards end of the report to make up for lost days.
3	Ergo application for Usability Study	3	4	12	Reorganise backlog and complete tasks that are

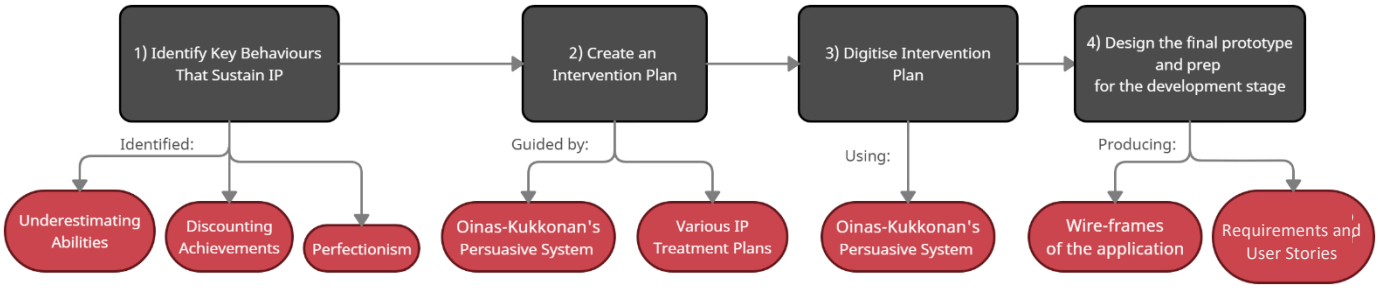
	takes longer than allotted 2-weeks				not reliant on the usability study application (such as the Technical Evaluation and writing sections of the final report)
4	Not recruiting enough participants for the Usability Study	3	3	9	Reach out to and recruit responders that expressed interest in taking part of any future studies relating to this project. Recruit friends and colleagues.
5	Users in Usability Study falling ill / Users drop out of usability study	3	4	12	During user recruitment, recruit backup users to replace any primary users.
6	Lockdown Restrictions halting face-to-face meetings with users in usability studies	4	3	12	Use university-approved Microsoft Teams to carry out the usability study
7	Difficulties during the Development Phase	3	4	12	Discuss Difficulties during Weekly meetings with the supervisor. Leave a comfortable amount of time for each sprint during the Development Phase. Narrow scope and focus on developing key aspects relevant to the project goals.

(figure 3.3: Risk Assessment table)

As mentioned above, item 3 did occur, although the solution proposed was not taken.

4 System Design

The design stage was carried out as per the pipeline:



(figure 4.1: Design Stage Pipeline)

4.1 Imposter Phenomenon Behaviours Study

4.1.1 Study Goals

The goal of the study was to identify key behaviours that sustain IP within an individual. The study was conducted through a survey which digitised the Clance IP scale (CIPs) discovered during the literature review process. The survey also had an option for the responder to be involved in the usability study related to this individual project.

4.1.2 Justification for Using Clance IP Scale

As mentioned in the background reading section; CIPs has proven to be a reliable metric to identify individuals who exhibit IP and those who do not. Research has also shown that CIPs has accurate internal consistency [9].

Furthermore, CIPs can be easily digitised, is quite intuitive, and quick for responders to complete making it perfectly suitable to acquire accurate results from university students.
For the above reasons, CIPs was chosen as the most ideal IP scale to be digitised and administered.

A copy of the survey (Digitised CIPs) has been appended (Appendix 3).

4.1.3 CIPs Breakdown and Sub-scaling

CIPs itself is a 20-item test with a 5-point scale of responses ranging from 1 (strongly disagree) to 5 (strongly agree). The final result is tallied from all the responses, and the total then identifies the severity of Imposter characteristics within the respondent in the range of:

1) 0-40: the respondent has few Imposter Phenomenon Characteristics (IPCs).
2) 41-60: the respondent has moderate IPCs.
3) 61-80: the respondent has frequent IPCs.
4) 81-100: the respondent often has intense IPCs.

To narrow down IP behaviours; the items in CIPs have been grouped based on their relation to certain behaviours. The groupings used were as such:

1) Fake – Underestimating Abilities: relates to the individual underestimating their own abilities and potentials.
2) Fake – Fear of Unmasking: relates to the individual feeling as an imposter and harbouring a fear of being found out.
3) Discount - Fear of Future Failure: relates to the individual harbouring fear of not meeting future expectations despite past accomplishments.
4) Discount – Acknowledgement: relates to the individual's inability to accept or acknowledge past achievements.
5) Perfectionism: relates to the individual's need for perfect results or to be the very best.
6) Luck – relates to the individual attributing success to luck, happenstance, or error.

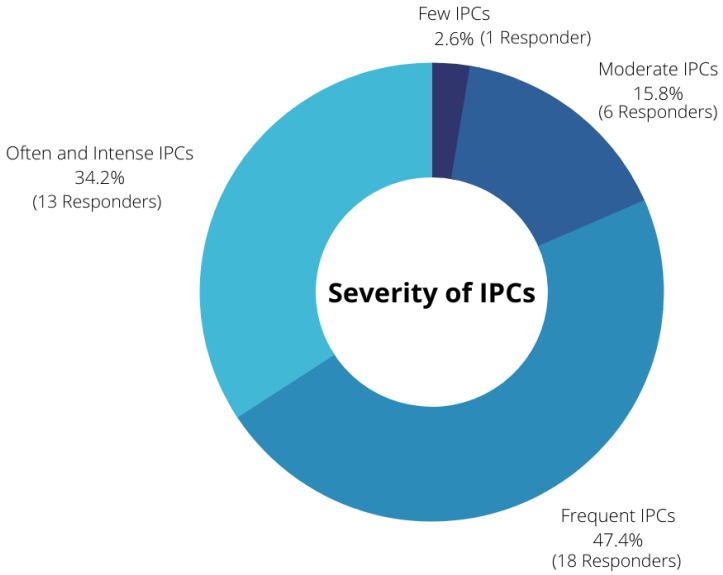
CIPs Subscales and Grouping has been appended (Appendix 4**)**

4.1.4 Survey Results

The survey was accessible through iSurvey and targeted University of Southampton students. A sample size of **(N = 38)** responses were collected. The relevant items for the goals of the study have been analysed as such:

1) The **mean** of the total (the tally of all responses) of all participants in the study space was calculated to be around **73.05**, with a Standard Deviation of **14.12**. Such a large mean highlights how common it is for students to experience IPCs.

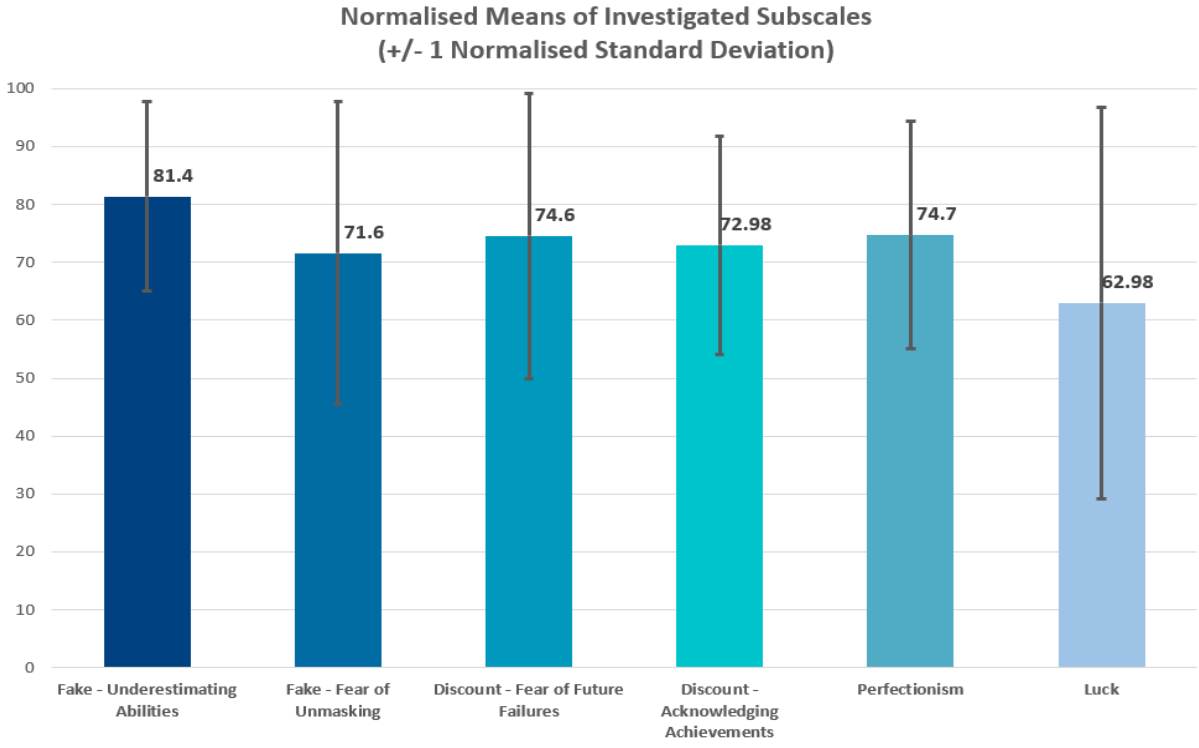
2) Pie Chart representing the spread of the Severity of Imposter Phenomenon Characteristics (IPCs) within the study space.



(figure 4.2: Pie Chart demonstrating Spread of Severity of IPCs)

The spread indicates that a sizable portion **(almost half)** of the study space experience IPCs frequently. In fact, only a small portion (2.6%, a single responder) experience few or no IPCs at all, further signifying how common it is to experience IPCs.

3) Bar chart of each investigated subscales, normalised as percentages, along with the normalised standard deviation (Chart is analysed in the following section):



(figure 4.3: Bar chart representing investigated subscales Mean and Standard Deviation)

4.1.5 Identifying key behaviours to target

Through the findings from the literature review and the subsequent study, several key behaviours that sustain Imposter characteristics within an individual have been identified as such:

1) Underestimating ability:

   The survey identified this subscale as having the highest mean and the smallest standard deviation, indicating that this behaviour is quite prevalent and common across responders.

2) Discounting achievements:

   The survey uses two subscales relating to discounting achievements: fear of future failures and acknowledging achievements. Both subscales have notable means. Of the two, targeting the behaviour of "Acknowledging achievements" would address both subscales as "Fear of future failures" stems from not acknowledging past successes.

   The Imposter Cycle also describes discounting achievements and attributing success to either luck or overpreparation as a key factor in continuing the cycle. Therefore, acknowledging achievements and past successes would interrupt the cycle and address this characteristic.

   Acknowledging achievements and past successes rather than attributing them to luck also addresses the Luck subscale investigated in the survey, further highlighting the significance of targeting this behaviour.

3) Perfectionism:

   The survey investigated the "Perfectionism" subscale which had the second highest mean amongst the investigated scales. The literature review also identifies "being a Superwoman/Superman" and the "need to be the very best" as characteristics of an individual experiencing the Imposter Phenomenon.

   Targeting this behaviour would therefore intervene against these characteristics.

4.2 Creating an Intervention Plan

4.2.1 Major Challenge

Although the Persuasive Systems Design (PSD) offered a framework to guide the process of creating the intervention plan, actually creating the intervention plan proved to be the largest challenge of this individual project.

This was largely due to the lack of a single, specific treatment plan for IP. Instead, IP is treated on a person by person basis and varies across specialists and therapy types. In addition, of the various treatments discovered through literature, most were guidance

and suggestions offered to councillors and patients and did not include tangible techniques, activities, or instructions to follow.

This challenge was overcome by integrating the various treatments discovered with several other treatments and techniques not specifically related to the Imposter Phenomenon, such as the Goal Setting theory, Fleischman's ability taxonomy, and proper reflection guides.

These integrated treatment techniques were used alongside PSD to create the intervention plan.

4.2.2 Oinas-Kukkonen's Persuasive Systems Design Framework

As briefly explored in the background research, PSD is guided through three distinct stages:

1) Persuasion Postulations: suggestions the designed intervention plan should follow to maximise the effectiveness of the persuasion.
2) Persuasion Context: carefully analysing the persuasion context through defining an intent, event, and a strategy of persuasion.
3) Persuasive Software Features: software features in which the previous components can be easily translated into a digital medium.

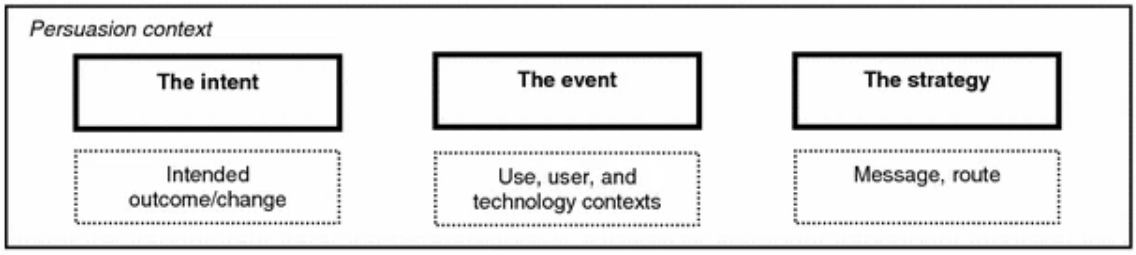
PSD Postulations

PSD postulations and suggestions were examined and lead to identifying several possible implementations to consider in the intervention plan.

A list of all postulations and resultant considerations in the IP intervention plan was appended (Appendix 5).

Persuasion Context

Persuasion context defines an intent, an event, and a strategy of persuasion as such:



(figure 4.4: Persuasive Systems Design Model: Persuasion Context Stage)

4.2.2.1 The intent:

The intent analyses the desired outcome and change of the intervention plan towards the target behaviours and can be broken down based on PSD's Outcome/Change Matrix [16], shown below:

	C-Change	B-Change	A-Change
F-Outcome	Forming an act of complying (F/C)	Forming a behavior (F/B)	Forming an attitude (F/A)
A-Outcome	Altering an act of complying (A/C)	Altering a behavior (A/B)	Altering an attitude (A/A)
R-Outcome	Reinforcing an act of complying (R/C)	Reinforcing a behavior (R/B)	Reinforcing an attitude (R/A)

(figure 4.5: Persuasive Systems Design Model: Outcome/Change Matrix)

Our general aim is to affect a behaviour change across all the key behaviours detected, thus all the changes are B-Changes.

The outcomes across all behaviours are A-outcomes, meaning the desired outcome is to alter a person's response to an issue. Defined as such:

1) Discounting Achievements: altering the behaviour from discounting an achievement into accepting achievements**.**
2) Perfectionism: altering the perfectionist trait of setting unrealistic goals to setting grounded goals.
3) Underestimating abilities: adopting a growth mentality and focusing on the growth of abilities rather than having a defeatist mentality.

4.2.2.2 The Event:

The event describes the use, user, and technological context.

The technological context describes the technological resources that will be implemented. As stated previously, this will be solely through an Android application.

The use context describes the ultimate purpose of the system, which is to effectively counter the key behaviours identified that sustain feelings of the Imposter Phenomenon. This suggests that the intervention plan itself will be split across handling the three key behaviours (Discounting Achievements, Underestimating Abilities, and Perfectionism).

The user context describes the user goals, which will range as the intervention plan is effectively split across the three behaviours, as such:

i) Discounting Achievements

The intent for this behaviour was identified as altering the user's behaviour towards achievements from a state of discounting into acceptance.

Various treatment plans for IP suggest achieving this by strengthening the links between the user and their accomplishments, learning to accept and acknowledge recognition, and recognising that achievements are granular (numerous within a single objective) [11][12].

The intervention plan would address this behaviour by including a section that collects the user's achievements. Achievements would be added automatically when users complete a goal, or manually by the user.

This introduces the first aspect and requirement of the intervention plan: The Achievements section and its various functionalities.

ii) Perfectionism:

The intent for this behaviour was identified as altering the perfectionist trait of setting unrealistic goals to setting grounded goals.

Treatment Plans for IP and Perfectionism have highlighted how vital it is to allow for a mindset that is prone to set realistic goals that are attainable, and in the case of not attaining those goals: Realising how the user responds to failure and to ensuring they do not personalize failures and allow them to affect their sense of self [12].

The intervention plan will address this behaviour by including a Goals Section and a Reflections Section.

The goals section will allow the user to view their goals (and each goal's tasks). The user will be able to add goals guided by Locke and Latham's Goal Setting theory [21].

When all the tasks within a goal are completed, the user will be able to reflect on various aspects of the completed goals such as achievements, abilities, meeting deadline, blockers, whether the outcome matched their initial expectation, and whether they personally regard the goal's outcome as a success.

They are then able to view their completed goals and subsequent reflections in the Reflections section.

This introduces two new aspects and requirement of the intervention plan: The Goals section and the Reflections section and their various functionalities.

iii) Underestimating abilities:

The intent for this behaviour is to adopt a growth mentality rather than having a defeatist mentality.

Treatment plans for IP commonly refer to adopting a growth mentality, and focusing on the growth of abilities with respect to an individual's abilities and skills [13].

The intervention plan will account for this behaviour by including an Abilities section where user could view a list of their abilities. When the user adds a goal, they will be asked to select related abilities. At the completion of this goal, abilities will progress appropriately.

The levels will range from 1-20, with the experience needed to reach each level being a simple exponential function:

$$\text{Level Exp} = 2^{level} * \text{modifier}$$

(Where modifier was set to 10).

The abilities chosen to add to the application were chosen based on Fleischman's research, which suggests that there is a finite set of abilities a human would use to perform tasks.

Fleischman compiled an abilities taxonomy that include both cognitive and motor abilities. The taxonomy includes 52 abilities and has been widely recognised and used for the last few decades. For the purposes of the treatment plan, only cognitive abilities were included, and some abilities were incorporated together where possible to cover a broader range of recognisable abilities.

The list of abilities implemented has been appended (Appendix 6).

This introduces a new aspect and requirement of the intervention plan: The Abilities section and its functionality.

4.2.2.3 The strategy:

The strategy includes the message and the route used in reaching the user.

The message relies on persuasion rather than convincing the user. This will be guaranteed by clearly presenting and informing the user regarding various information.

Information presented will include:

1) The nature of the imposter phenomenon, its reasons, effects, and characteristics
2) The identified key behaviours sustaining IP, and how the user's interaction with the system prioritised their detected behaviours
3) The Intervention plan, and how the system will carry out the behavioural change.
4) Various guides on using the application and the background research that informed the design.

This introduces a further requirement of the intervention plan: The Information section and its various content.

The route defines the persuasion method to be taken (direct/non-direct). The system will take a **direct** route through clearly presenting the content and goals of the system and the intended aims and effects.

4.3 Digitising Intervention Plan

After identifying and mapping out various aspects of the intervention plan, the created intervention plan was ready to be digitised to be delivered through a smartphone application.

As briefly explored in the background research section, PSD defines various software features that guide translating the previous components into a digital medium. These are described under four categories:

1. Primary Task Support: features supporting the user in completing the primary activities through reducing complex behaviour into simpler ones.
2. Dialogue Support: features easing the completion of the tailored plan goal.
3. Credibility: features relating to designing a more believable system, thereby making it more persuasive.
4. Social Support: utilising social networking elements to motivate the users.

Each category offers several design principles. However, PSD does not necessitate the inclusion of all the design principles features into the digital design. The features merely exist to ease the digitising process and to effectively translate the intervention plan into a digital medium.

Just as with postulations, several of these design features were used to guide the digitising process and were implemented in the designed solution. **A table of these implementations has been appended (Appendix 7).**

4.4 User Stories (Requirements)

After the intervention plan was created and digitised, a set of requirements for the smartphone application was compiled (figure 4.6). These requirements have been written as User Stories. A User Story is a common approach used in Agile which ensures that the user's goals remain at the centre of the application's development process, making them a perfect tool to ensure the requirements are mapped to the user's goals that were identified when creating the intervention plan (Section 4.2.2).

Each user story is accompanied by a requirement, these define the acceptance criteria that must be met to consider the user story a success.

These requirements were prioritised using MoSCoW's prioritisation technique, another common tool used in Agile. MoSCoW prioritises the stories as such:

1) Must: Requirement that must be met for the solution to be considered a success.
2) Should: High-Priority requirement that should be included in the final solution if possible.
3) Could: Low-Priority requirement that is desirable, but not mandatory for the final solution.
4) Won't: A requirement that has been identified not to be included in the final solution but may be considered in future work.

No.	MoSCoW	Section	User Story	Requirement
1	MUST	Setup	As a user, I want to be able to be able to read about and conduct a CIPs Survey To get a CIPs Score, identify behaviours, and get a personal Intervention Plan	R1: Setup introduces users to CIPs R2: Users can conduct CIPs at setup. R3: System calculates User's CIPs Score R4: System identifies target behaviours R5: System creates a personal plan by prioritising behaviours.
2	MUST	Setup, Main	As a user, I want the system to record my setup results, So that they may be saved when I use the system.	R6: System stores Setup data. R7: System loads setup data at application start.
3	MUST	Main	As a user, I want to be able to navigate the entire system through several tabs. So that traversing through the various tabs is seamless.	R8: application should have a navigation drawer to traverse through tabs/sections. R9: main page should display active tab/section.
4	MUST	Information	As a user, I want an information tab that includes all relevant, key, and reliable information (about IP, DBI, and the application). So that I can gain information about various topics, be able to verify the information, and be confident that the application is transparent.	R10: Information Tab contains information entries. R11: User can scroll across information entries R12: User can select Information entry R13: User should be able to read through activity.
5	MUST	Achievement	As a user, I want an achievements Tab Where I can see all past achievements. So, I may keep track of my achievements and learn to acknowledge past achievements.	R14: Achievements Tab records achievements R15: User can select achievement to view.
6	MUST	Achievement	As a user, I want to be achievements to be able to add achievements. So, I may see my growth and learn to acknowledge past achievements.	R16: User can start "add achievement" activity by selecting the add achievement button. R17: User can add achievement name R18: User can add achievement type R19: User can add achievement details R20: User can add achievement date
7	MUST	Abilities	As a user, I want an abilities tab that lists various abilities and skills, To keep track of my various skills.	R21: User can view abilities in abilities tab R22: User can select drop down option to view further details.
9	MUST	Abilities, Goal	As a user, I want my abilities to "grow" as I complete goals.	R23: System automatically adds exp to related abilities when goal is complete

			So that I may visually perceive my growth and stop underestimating my abilities.	
10	**MUST**	Goals	As a user, I want to be able to add, remove and view future goals, So, I may view all my upcoming goals and tasks.	R24: User can view goals in goals Tab R25: Users can view tasks related to each goal R26: User can switch across different goals. R27: User can long tap a goal to see further detail. R28: User can delete goal. R29: User can add a goal. R30: User can add goal name. R31: User can add goal type. R32: User can add goal details. R33: User can add goal deadline. R34: User can select related abilities.
11	**MUST**	Goals	As a user, I want to be able to add, edit, remove, and check off tasks within a goal. So, I may progress and view the goal until completion.	R35: User can edit task name. R36: User can delete task. R37: User can check off completed task. R38: application records completed tasks.
12	**MUST**	Reflection	As a user, I want to be able to able to reflect a goal when all the tasks are complete. So, I may learn to reflect, and ground my expectations.	R39: User can reflect completed goal. R40: User can reflect on greatest achievement. R41: User can reflect on best ability R42: User can reflect on blocker. R43: User can reflect on deadline. R44: User can reflect on success. R45: User can reflect on expectation. R46: System Removes reflected goals. R47: Reflected goals are added to reflections tab
13	**SHOULD**	Setup	As a user, I want to be able to add my name and an image, So that I feel the application is more personal.	R48: Setup must start on first usage. R49: user must add a name during setup R50: user can add a picture during setup
14	**SHOULD**	Main	As a user, I want guidance on what each tab is, and how to use it. So I may learn to use the application effectively.	R51: Each tab should contain a help button R52: User can select button and receive a Pop-up.
15	**SHOULD**	Personal	As a user, I want a personal section displaying my selected name and picture. So that the application feels personal.	R53: User should be able to view their personal details.
16	**SHOULD**	Personal	As a user, I want the personal section to include my prioritised plan, and I	R54: User should see personal plan in personal tab.

			want to be able to click through the plan. So that I can see my plan at any time and understand each targeted behaviour.	R55: User should be able to view more detail about their plan when selecting each behaviour.
17	**SHOULD**	Information	As a user, I want to be able to click on an Information entry, and be able to view the entry, as well as keep progress of my reading. So that I may fully engage with the information section and benefit from the content.	R56: User should be able to see their progress when reading. R57: System should keep track of user reading progress. R58: Information should be unlocked sequentially.
18	**SHOULD**	Goals, Achievement	As a user, I want achievements to be added automatically when finishing a goal, So I may see an automatic growth upon goal completion.	R59: System should add automatic achievements when finishing goals.
19	**SHOULD**	Goals, Achievement, Reflection	As a user, I want the system to recognise whether I completed the goal before or after a deadline. So I may either recognise this as an achievement, or learn to correct this.	R60: System should detect completion and deadline. R61: System should give achievement if deadline met.
20	**SHOULD**	Reflection	As a user, I want to be able to see all past reflections. To keep track of reflection and practice proper reflections.	R62: Reflections tab contains past reflections R63: Past reflection should contain goal information. R64: Past reflection should contain all completed tasks. R65: Past reflection should contain user reflection information.
21	**SHOULD**	CIPs	As a user, I want to be able to conduct a CIPs survey at any time, So I may see a more recent score and breakdown of targeted behaviours.	R66: CIPs sections contains past CIPs. R67: User can take more CIPs surveys. R68: User can drop down CIPs Breakdown.
22	**COULD**	Achievement	As a user, I want my achievements to have scores, So I may gain a sense of competition and achievement when getting new achievements.	R69: Achievements tab displays scores R70: Achievements tab calculates sum achievement scores.
23	**COULD**	Main	As a user, I want a reset button So I can erase my usage of the application, and maybe start over.	R71: User can select the reset button to delete all information and reset the application.
24	**WON'T**	Main	As a user, I want the system to unlock the application tabs sequentially, So I am not overwhelmed by all the tabs.	R72: application prioritises tabs. R73: application unlocks tabs sequentially.
25	**WON'T**	Main	As a user, I want to receive notifications,	R74: User can set notifications. R75: System notifies the user based on selection.

			So I may be reminded to use the application.	
26	**WON'T**	Main	As a user, I would like to have a supervisor get access to the application, So they may verify my growth and support me through it.	R76: User can add other user as supervisor R77: User can set access to supervisor
27	**WON'T**	Main	As a supervisor, I want to be able to view and comment on a user's actions. So I may aid the user through the intervention.	R78: Supervisor has access to allowed information and tabs. R79: Supervisor can comment on user's actions.
28	**WON'T**	Personal	As a user, I want to be able to login to a profile, So that the application could keep my information synced online.	R80: User can set a username and password. R81: User can login at application start. R82: System can authenticate users. R83: System can populate information from an online server,
29	**WON'T**	CIPs	As a user, I want the system to track my CIPs scores, So I may see a graph of my differences.	R84: CIPs tab includes graphs of users CIPs Results. R85: Users can modify granularity of CIPs Graph. R86: Users can switch between graph of different abilities.

(figure 4.6: List of Gathered Application Requirements, Prioritisations, and Requirements (Acceptance Criteria))

4.5 Wireframes

With the intervention plan created, a plan to digitise it set, and clear requirements identified, wireframes of the application were created to offer a proof-of-concept.

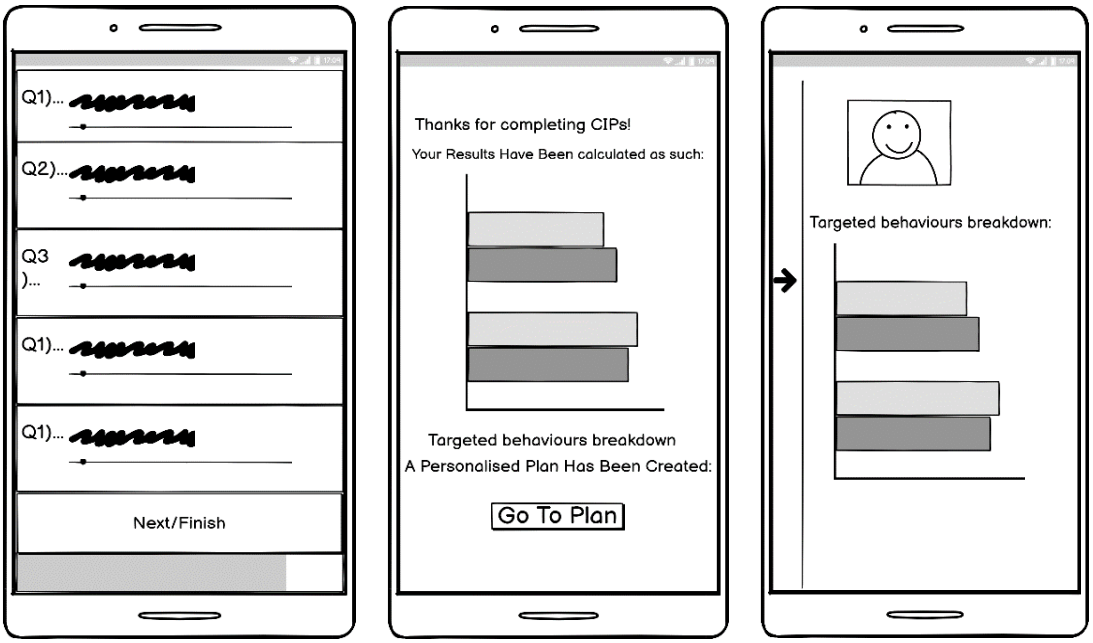
Low-fidelity wireframes were chosen as an alternative to high-fidelity wireframes as the purpose of these wireframes is to simply convey a general feel and offer a clear vision of the system rather than strictly outlining a design to adhere to. In addition, designing low-fidelity wireframes was more efficient and allowed more time to be allotted on development and subsequent stages.

These low-fidelity wireframes were developed using Balsamiq, which is an intuitive tool that offered various interfaces and options that are standard and commonplace across Android applications.

As guided by the PSD, the designs opted for were intuitive, learnable, and recognisable. As such, the design focused on maintaining a consistent style and implemented various intuitive and well-known Android styles and features, ranging from buttons, to progress bars, and a navigation drawer.

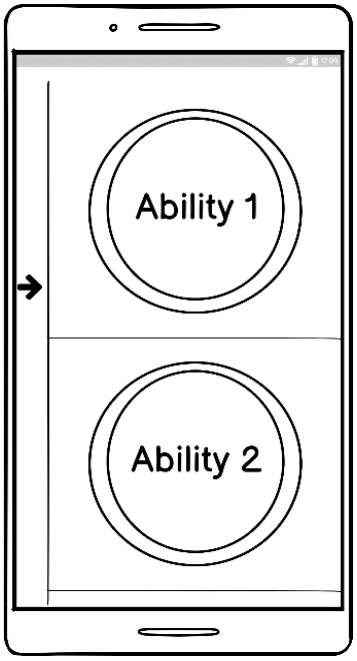
Some prominent wireframes are:

1) Setup Section Wireframes:



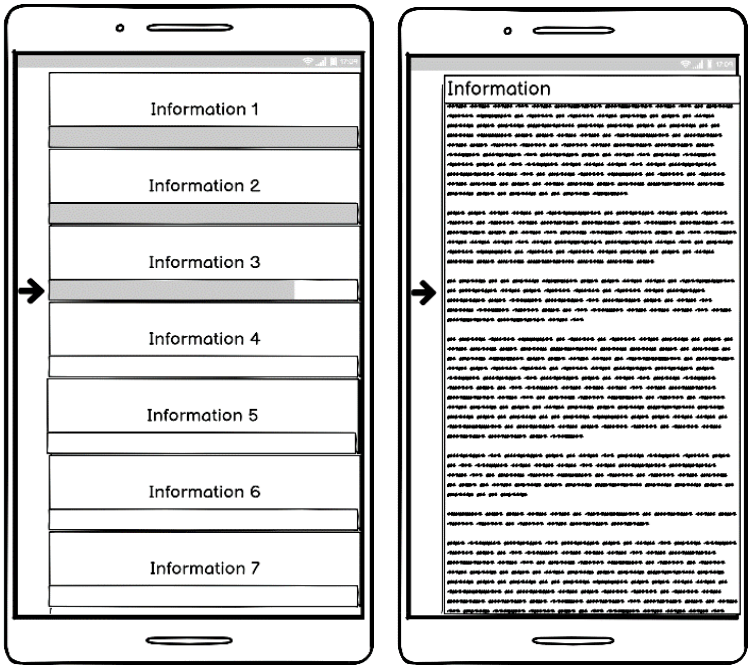
(figure 4.7: Setup Section Balsamiq Wireframes)

2) Abilities Section Wireframes:



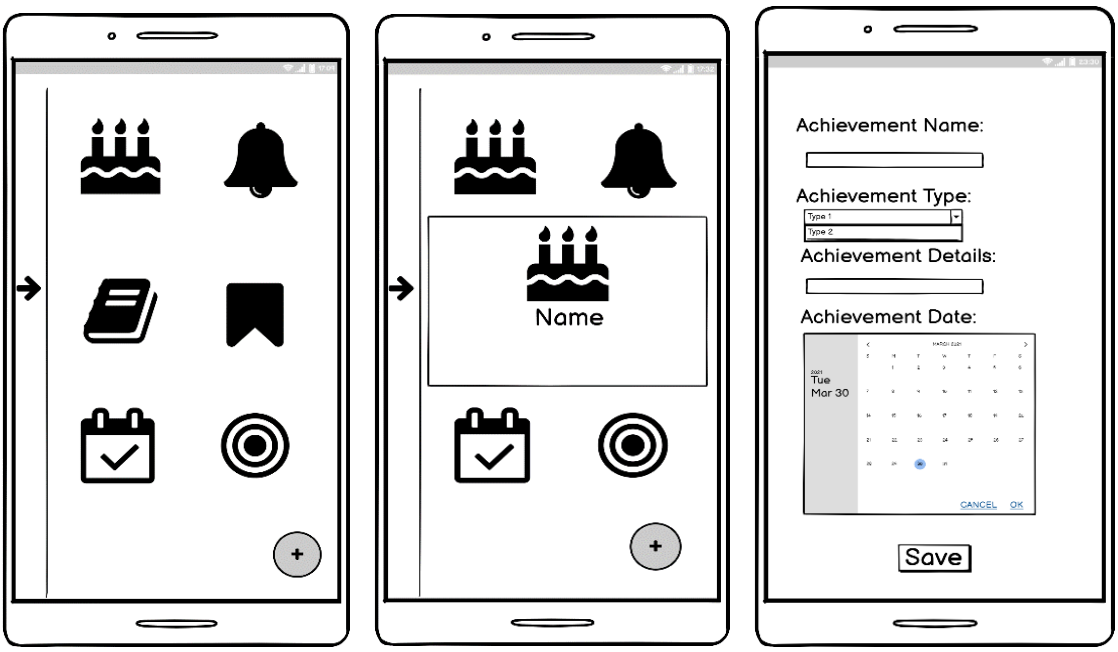
(figure 4.8: Abilities Section Balsamiq Wireframes)

3) Information Section Wireframes:



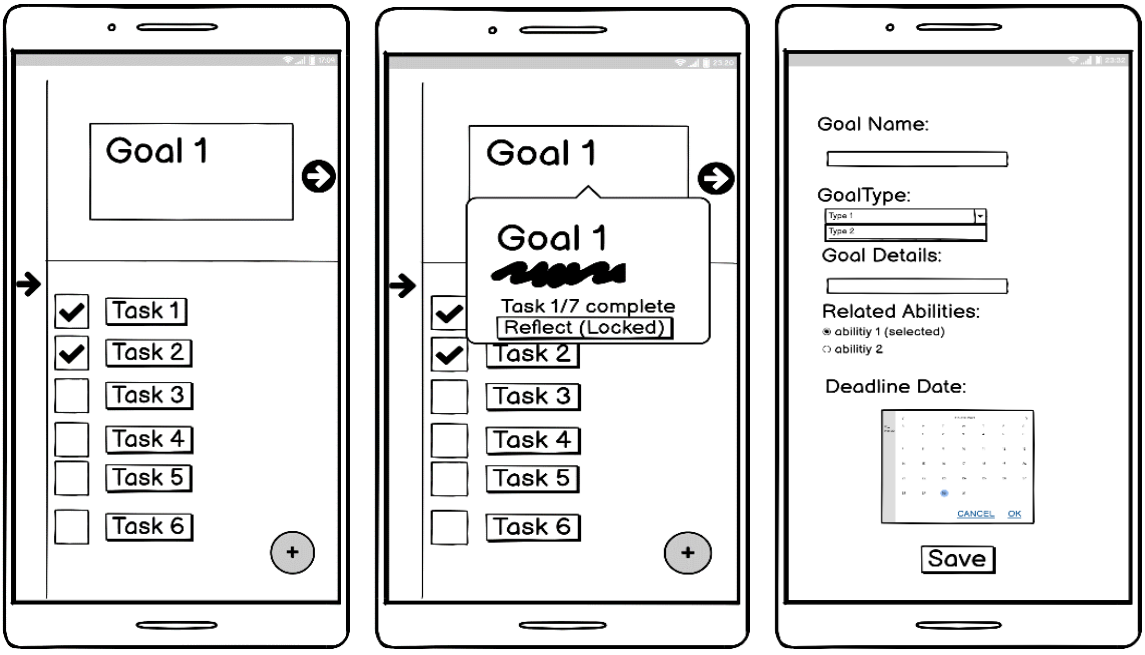
(figure 4.9: Information Section Balsamiq Wireframes)

4) Achievements Section Wireframes:



(figure 4.10: Achievements Section Balsamiq Wireframes)

5) Goals Section Wireframes:



(figure 4.11: Goals Section Balsamiq Wireframes)

5 Implementation and Development

5.1 Tools and Infrastructure:

Android Studio

The latest version (4.1) of Android Studio was chosen to develop the application.

Android Studio was chosen as it offers a free student license and testing during development can be carried out on both virtual and personal devices. In addition, any usability testing and evaluation can be intuitively carried out on a vast majority of android devices.

SQLite

Data storage is vital for the functionality of application, as content needs to be stored to populate the application, and the user's interactions, achievements, goals, reflections, and responses need to be tracked.

The decision was made to use an offline storage rather than implement an online-sync database, as offline storage would function without a required internet connection. In addition, using offline storage would offer the user more control and privacy regarding their data, which, given the sensitivity of the topic, is a vital concern.

The detriment to using an offline database lies in not having an online backup, meaning if the user uninstalls the application, all information would be lost. This was deemed an acceptable trade-off, as this application is considered to be a prototype, and implementing an offline database is sufficient to explore the goals of the project.

SQLite was selected for all data and database purposes. SQLite is an open-source relational database, and it was selected over File Storage as it carries several advantages, most notably; it allows structured storing of data, has higher performance and insubstantial read-write times, allows for faster and more robust data querying, and the database is only visible in the application that created it [24].

Trello and Excel

Trello was used to schedule, plan, and track the sprints as it is a popular platform used by Agile developers and offers various templates for sprints.

An Excel template was used for the burndown chart.

5.2 System Architecture

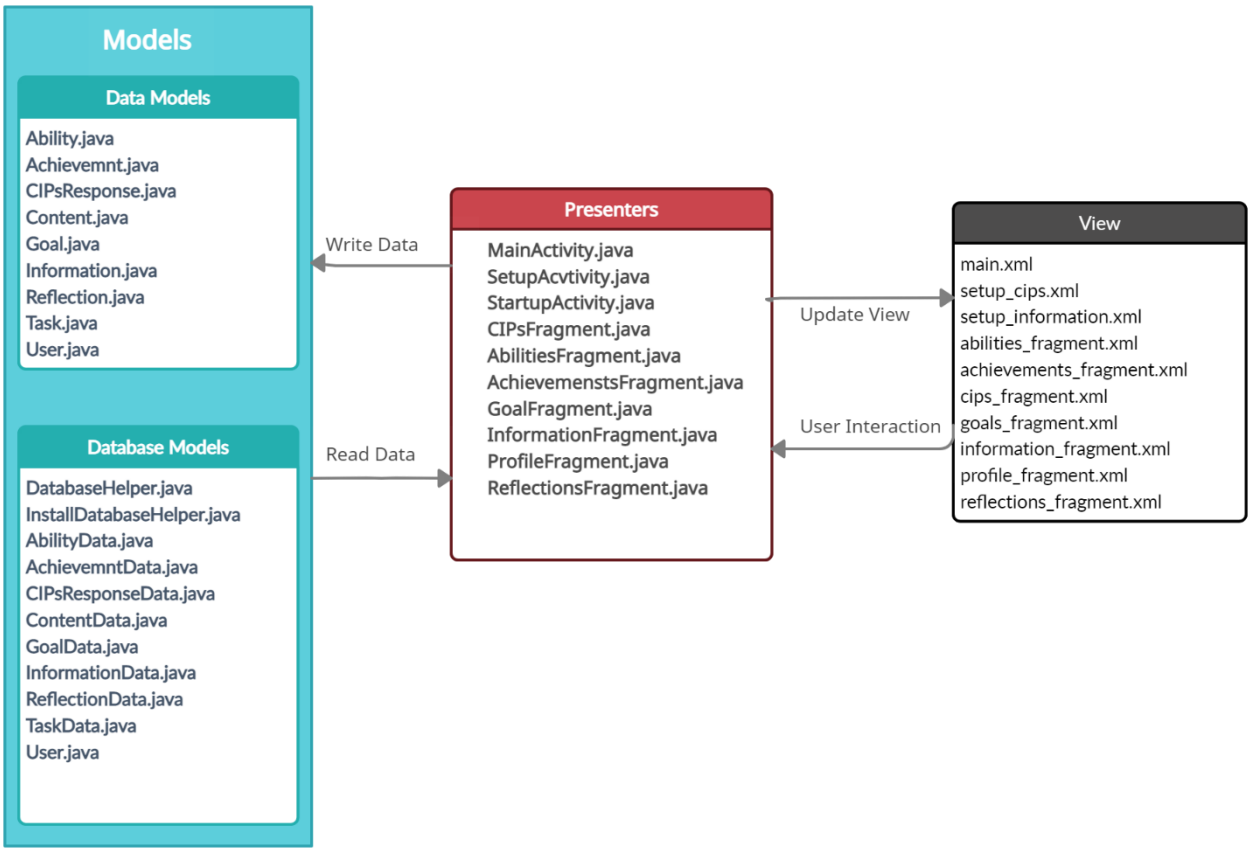
5.2.1 MVP Pattern

The Model-View-Presenter (MVP) pattern is a popular architectural pattern derived from the common Model-View-Controller Pattern. It is used widely in Android development for applications that contain a user-interface [25].

MVP divides the system components across three separate categories. The **Model** consists of the classes that contain the data that are mapped with the database's tables, services that support the system, and database helpers that handle interaction with the database. The **View** is responsible for displaying the user interface, the user's interaction with the system, and directing the user's actions (events) to the Presenter. The **Presenter** acts as the connection between the Model and View. It receives the data from the Model and the events from the View and handles their interaction, as such the Model and View are separate.

MVP was used as the architectural structure for the application as it allows for a more modular, testable, and clean structure.

The following diagram presents the **notable** classes of the application, and their allocation within the MVP pattern:



(figure 5.1: Developed Prototype's MVP Classes Structure)

The Model classes contains data classes, each of which has counterpart table in the Database.

The View consists of Layout files (XML Format), each layout file represents a full view screen, a pop-up template, or recyclable cards (Achievement Card, Goal Card…etc).

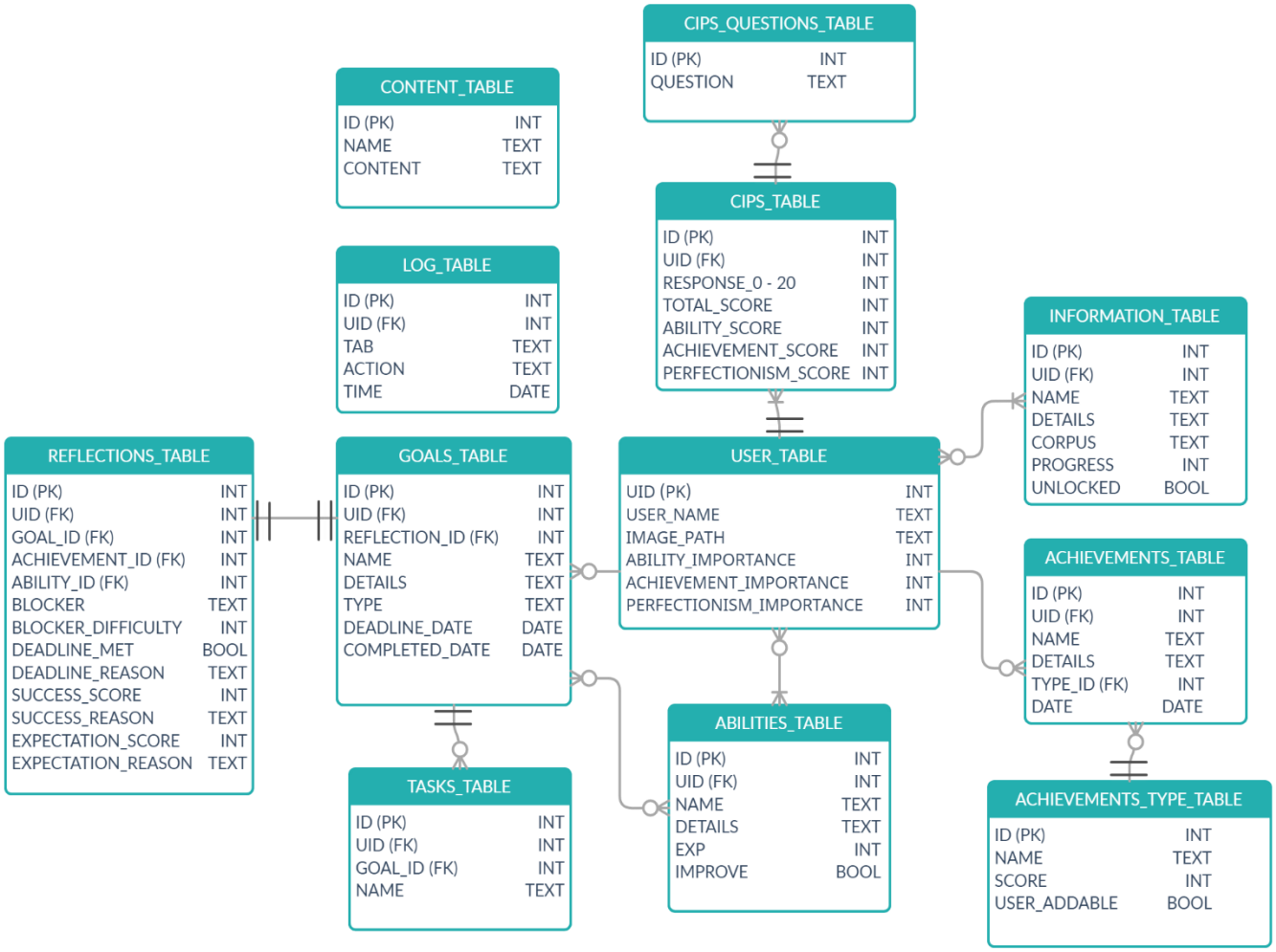
The Presenter consists of Activity and Fragment files which handle the various functionalities of the application.

5.2.2 Database Structure

As mentioned above, data storage is a vital aspect of this application. As such, two databases were created:

1) Install Database: this database is located within the assets folder of the application (packaged in the application) and is used to move necessary content to the usage database during setup. As such, it contains the abilities, achievement types, information, and content tables.

2) Usage database: this database is the main database used in the application and is created during setup. Its structure is as shown in (figure 5.2).



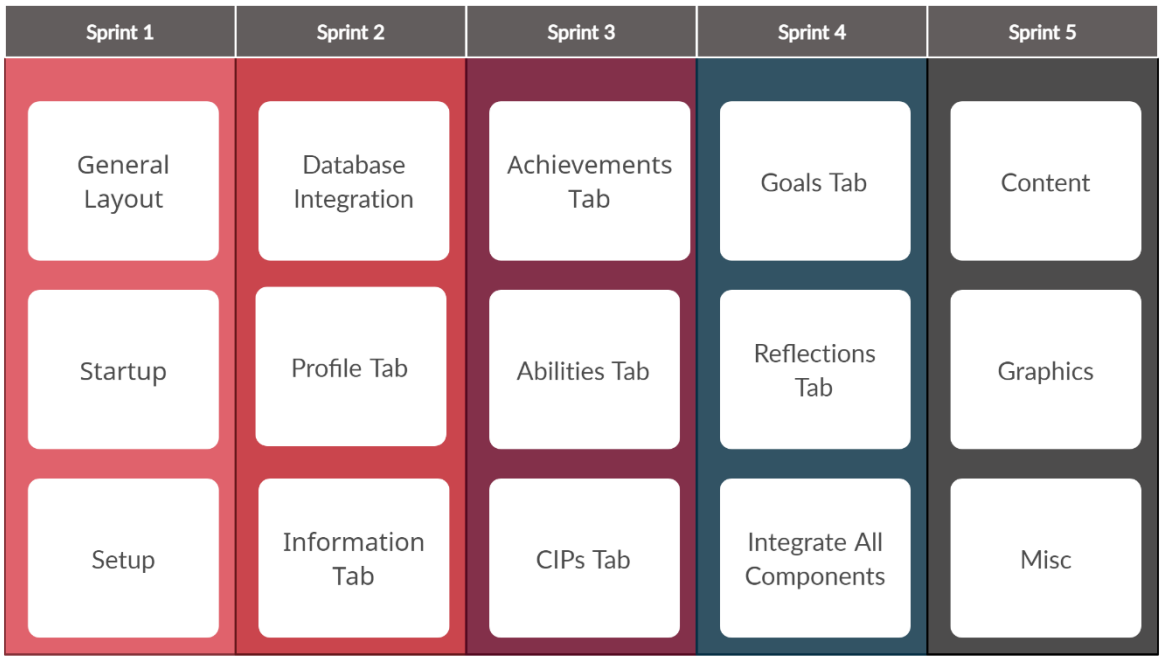
(figure 5.2: Usage Database Relational Structure)

5.3 Implementation

5.3.1 Backlog, Sprint Plan, and Burndown

While the project structure followed waterfall-like sequential planning, the development stage itself used a range of Agile methods and tools. The requirements compiled in the design stage were added to a project backlog, a burndown chart was maintained in Excel (**Appendix 8**), and Trello was used to divide the backlog into five sprints.

The sprint plan was split as such:



(figure 5.3: Sprint Plan Sections Breakdown)

A more in-depth breakdown, including the user stories assigned to each sprint, has been appended (**Appendix 9**).

5.4 Major Challenges and Decisions

As it would be impractical to list all the decisions and challenges faced during the development, a quick overview of the most notable ones is as follows:

5.4.1 Data persistence

A major challenge in the development of the application was maintaining data persistence. More specifically, as data is continuously being read and written to the database, it was essential to ascertain that every data modification is recorded properly and at the right time, while also ensuring read-write times do not affect the system's response times.

This especially presented a challenge considering Android's use of concurrent applications, where the user can easily switch between screens and force close the application at any time. A solution to this could be ensuring data is read-written when

the user switches the active application or force closes it. But this is considered a bad programming practice, as large read-write during shut down does risks the data being modified incorrectly, and might lead to a noticeable lag, affecting the user experience.

Instead, data persistence was ensured through various techniques. To start, whenever a database is accessed for read-write operations, it is locked from all other read-write calls. This ensured data would be modified correctly by a single service at a time. As SQLite was used, read-write times are extremely minimal, therefore locking the database did not affect response time to a noticeable level.

Second, data modification, where possible, occurs at the end of an activity. Such as when adding a new achievement, the achievement is only added to the database when the user selects the “save achievement” button.

The exception to this is in the Goals tab, where the user could affect different types of changes to various goals on the same activity. To account for this, goal data is only written when the user leaves the goals tab to any other tab.

5.4.2 Avoiding information overload

Another consideration was ensuring the user would not be overloaded with information, which is a challenge given the amount of content and information the application must relay to the user to ensure the intervention plan’s goals are met.

As such, several considerations have been taken to reduce information overload, and segment information without the need to remove essential information to relay.

An example of this is using help buttons across the application, where the user might tap the buttons, and receive a pop-up containing guiding information. There are help buttons at every tab, providing some essential information and usage-guidance, as well as help buttons guiding the user when adding a new achievement or goal, or reflecting upon goal completion.

5.4.3 Fifth Sprint

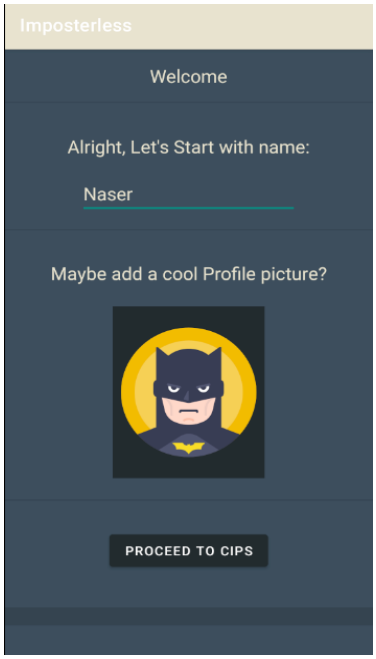
Initially, the development stage consisted of four sprints. However, an additional sprint was added to research and add content to populate the application. This extra week was essential to ensure the application would be populated with correct, reliable, and verifiable content, which are important aspects suggested by the Persuasive Systems Design model.

Adding an extra sprint, also allowed for more concentrated efforts to be placed upon the graphical design of the application, as well as several miscellaneous aspects. All of which would ensure the application is more engaging, usable, and accessible to the users.

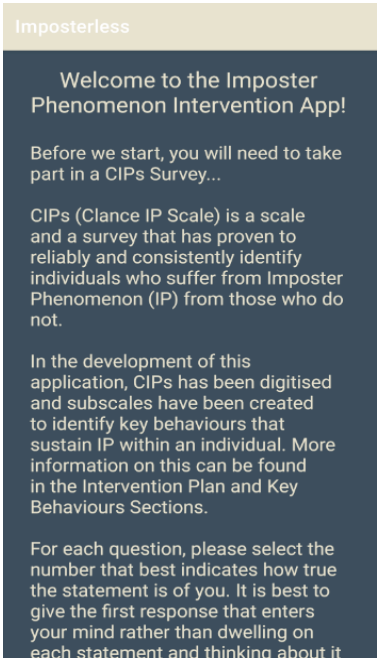
5.5 Final Application

After the completion of the sprints, development on the prototype application (titled “Imposterless”) was complete. A run through of the notable features and screens are as such:

5.5.1 Setup Section:

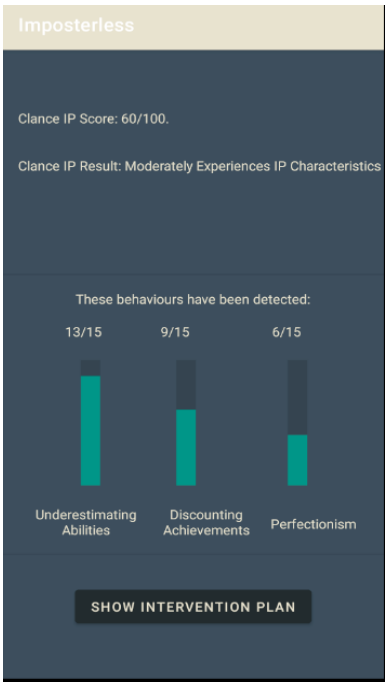


When the user runs the application for the first time, they are taken into the setup section. Where they are asked to select a name and a picture (solely for personalisation purposes). They are then given some information about the Clance IP Scale (CIPs).



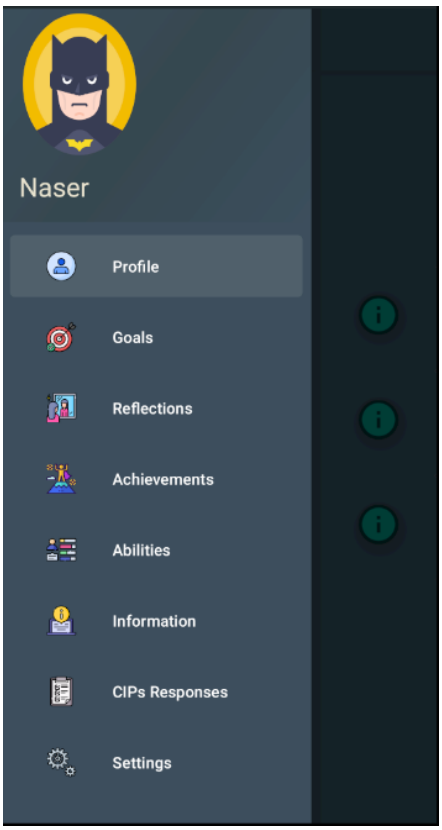
(figure 5.4: Application Screen: Setup Personalisation + CIPs Information Screen)

They then take part in the digitised CIPs survey, and their results are calculated, and the behaviours prioritised in their treatment plan.



(figure 5.5: Application Screen: Digitised CIPs + Behaviours Calculation Screen)

5.5.2 Navigation:

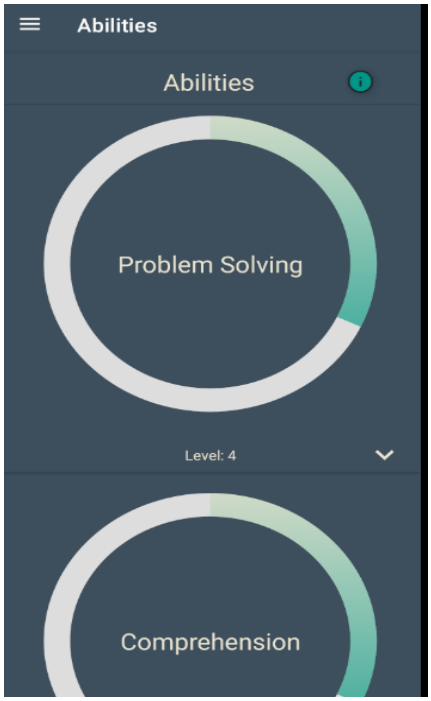


As identified in the previous stages; the application needed to include several separate sections. To ensure incrementality and reduce content load, a navigation drawer was used to easily traverse across sections. This navigation drawer will be available across sections and will be hidden when an activity requiring the user's full attention takes place.

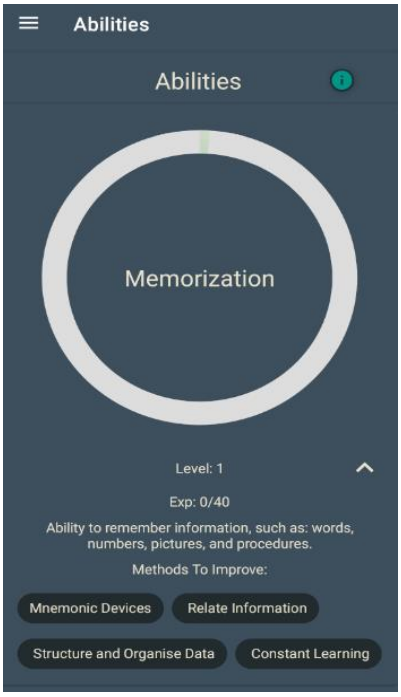
The main activity starts after the user has finished the setup activity. And consists of two components: the main content page that displays the current active tab, and the navigation drawer to navigate across the different tabs.

(figure 5.5: Application Screen: Navigation Drawer)

5.5.3 Abilities Section:



The Abilities section lists each ability as a circular progress bar and allows the user to "drop down" various additional information.

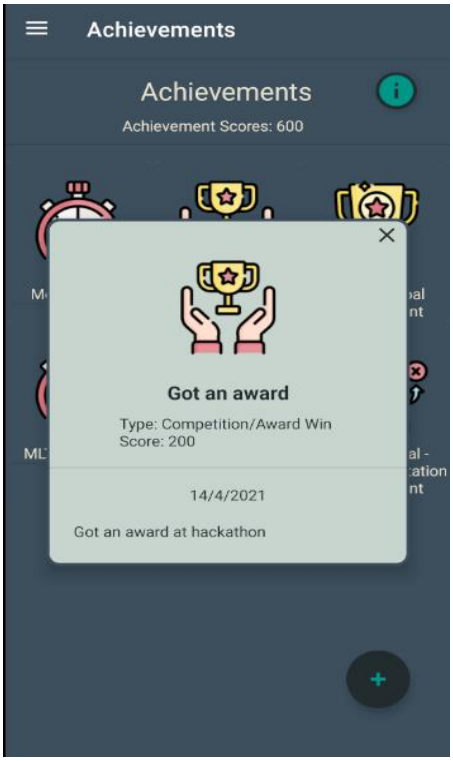


(figure 5.6: Application Screen: Abilities Section)

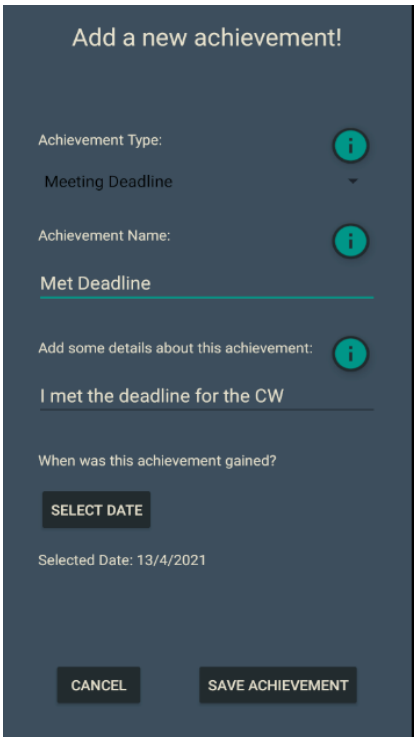
5.5.4 Achievements Section:

The Achievements section lists each achievement and the total achievement score the user has gained so far. The score is dependent on the achievement type (A table of achievement types and their scores has been appended as Appendix 10).

Each achievement can be viewed as a popup containing further details.



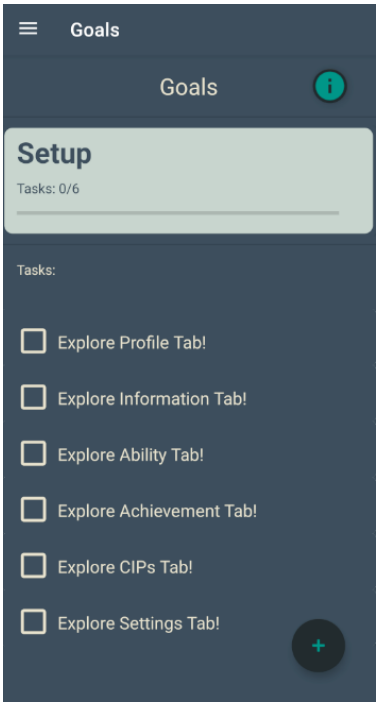
(figure 5.7: Application Screen: Achievements Tab + Achievement Popup)



Achievements are added automatically at the completion of a goal or can be added manually by tapping the floating button anchored on the bottom of the screen. This will transport the user to a separate activity. The add achievement activity is segmented into sections to guide and increase their motivation and ability. The section also contains various help buttons to guide the user throughout the process.

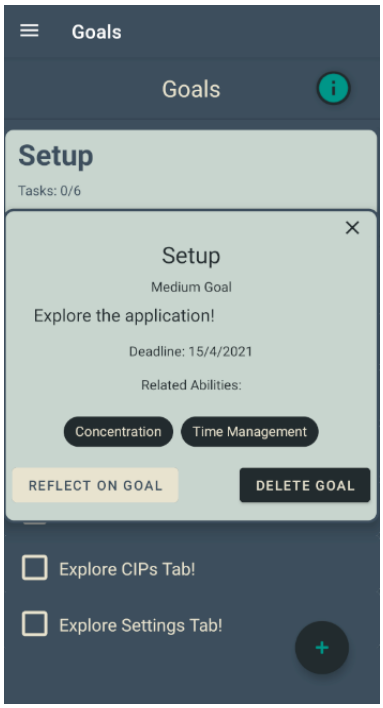
(figure 5.8: Application Screen: Add Achievement Activity)

5.5.5 Goals Section:



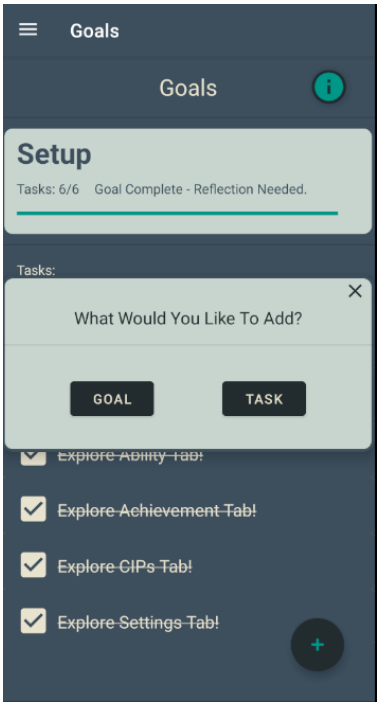
The Goals section is segmented into two parts, a top horizontal scroll bar to list all pending goals, and a bottom vertical scroll bar listing tasks relating to each goal.

The user can long tap a goal or a task to prompt a pop-up that will contain further details for the goals and further options for the tasks.

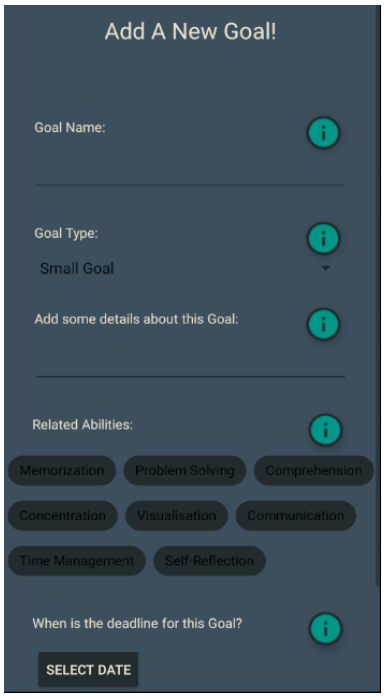


(figure 5.9: Application Screen: Goals Section + Goals Popup)

Consistent with the add achievements activity, users can add goals and tasks by tapping the floating button anchored to the bottom of the screen. This will prompt a pop-up allowing the user to specify whether they would like to add a task or a goal.

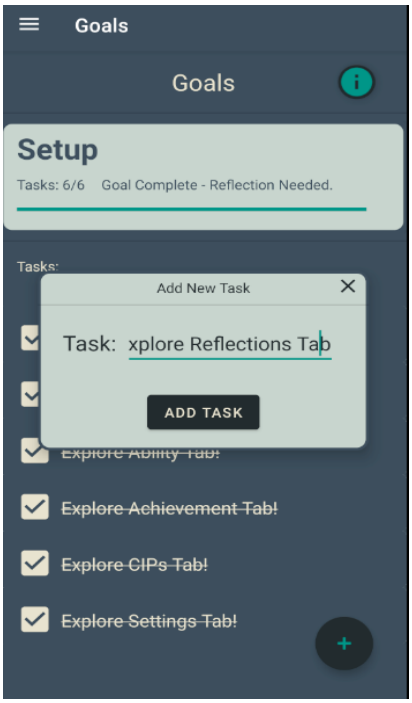


(figure 5.10: Application Screen: Add Goals/Task Choice Popup)



(figure 5.11: Add Goals Activity)

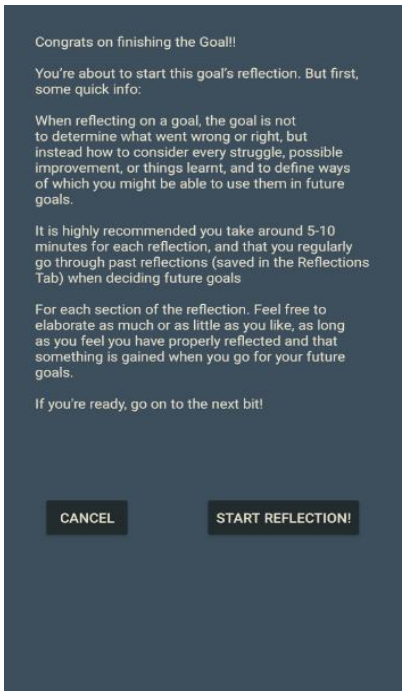
Adding tasks is simply defining the task's name, while adding a goal will start an add goal activity, similar to the add achievements activity. The help buttons in the "add goals activity" guide the user as per the Goal Setting theory discussed.



(figure 5.12: Add Tasks Popup)

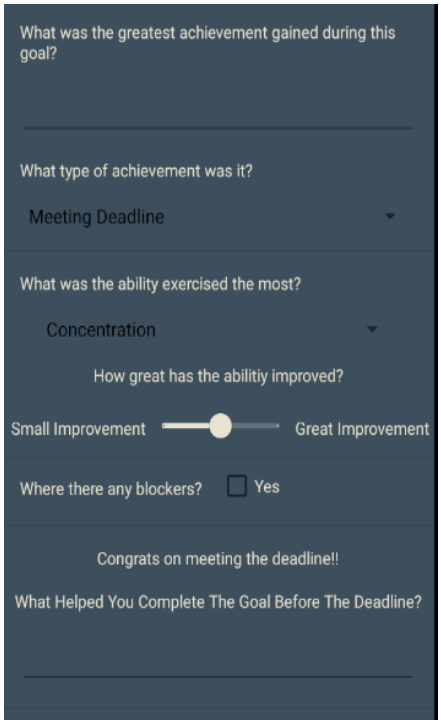
When all the tasks are completed, a prompt will appear indicating a goal is ready for reflection, which can be initiated through the reflect achievement button appearing in the goal popup.

5.5.6 Reflection Activity:

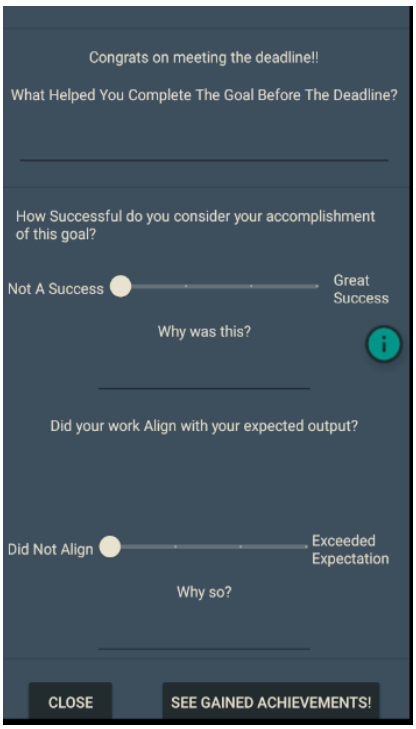


When a user decides to reflect on a goal, they are first given a brief guide into proper reflection before taken into the reflection form.

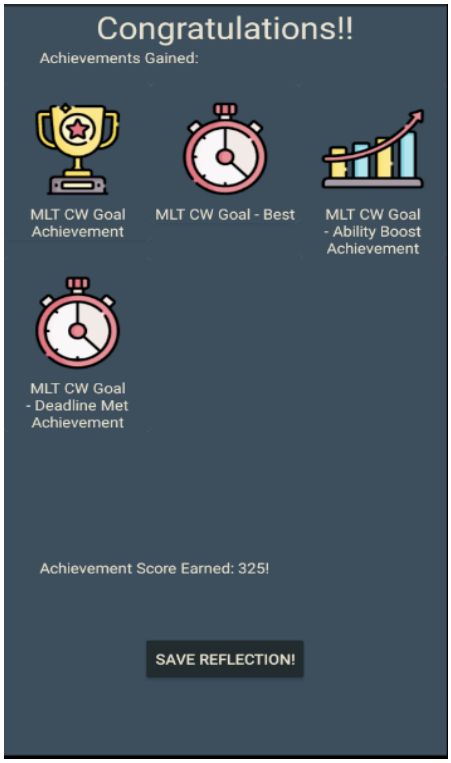
(figure 5.13: Reflection Activity: Reflection Information)



The reflection form asks the user to introspectively reflect on several aspects of the completed goal, such as blockers, whether the result aligns with their expectations, and whether they consider the result a success. The form is adaptive to the user's input, allowing further details to be added if needed. For example, when the user selects a low score.



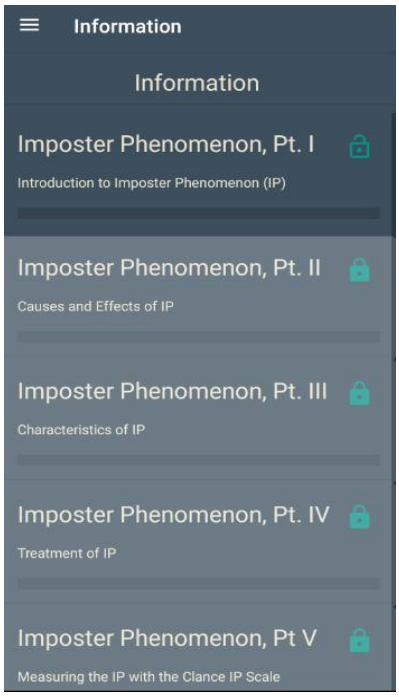
(figure 5.14: Reflection Activity: Adaptive Reflection Form)



When the user completes the reflection, a list of gained achievements are shown. The goal and reflection are then added to the reflections tab.

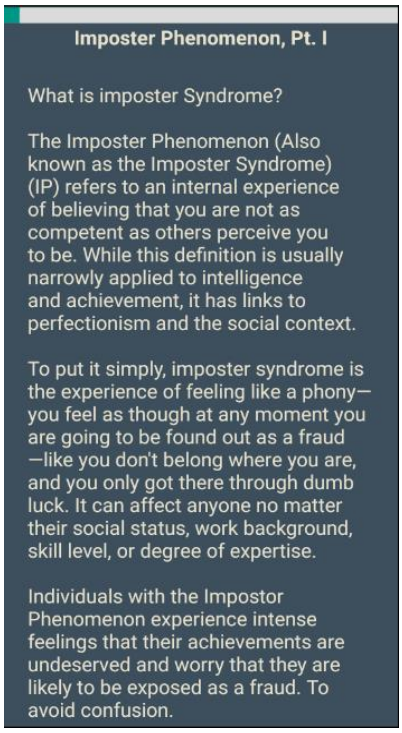
(figure 5.15: Reflection Activity: Gained Achievements)

5.5.7 Information Section:



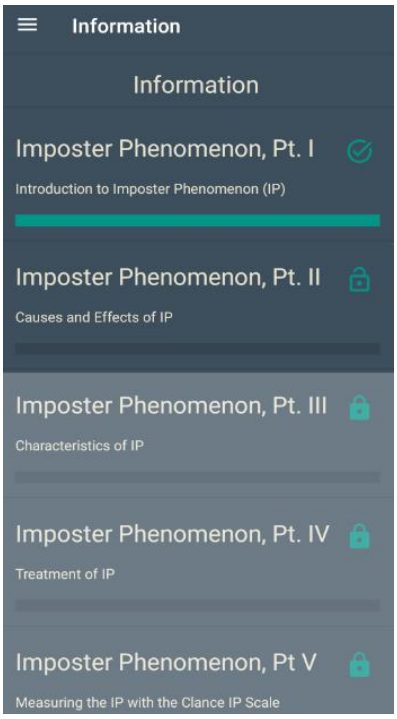
The Information Section contains various entries to familiarise the user about the Imposter Phenomenon, Digital Behavioural interventions, and various aspects of the designed application. It also ensures transparency, validity, and verifiability of the intervention plan and application.

(figure 5.16: Application Screen: Information Section)



(figure 5.17: View Information Activity)

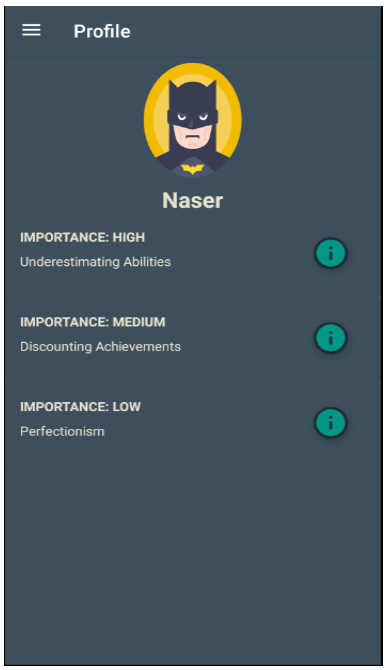
When a user selects an entry, they are taken into the view information activity, where they can read through the content of the selected information entry, their progress is then saved, and the next entry is sequentially unlocked.



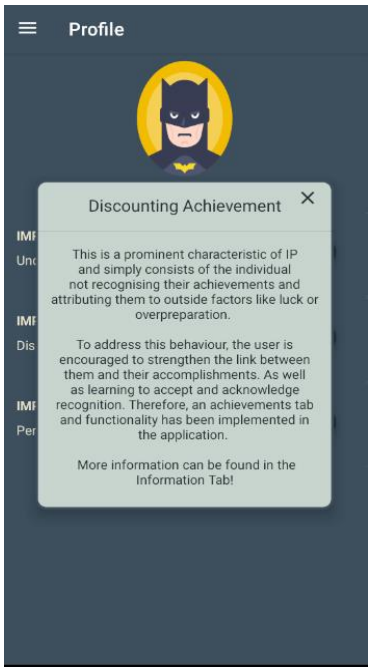
(figure 5.18: Information Entries Sequential Unlock)

5.5.8 Other sections:

Profile:

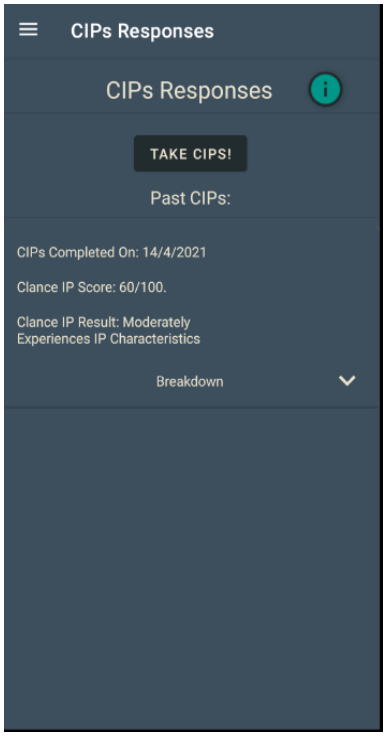


The Profile section exists solely to add a personalisation element to the application and simply contains an image and the user's prioritised behaviours.



(figure 5.19: Application Screen: Profile Section + Behaviour Popup)

The Reflections and CIPs sections are similar and simply present all past reflections and taken CIPs for the user to view.



(figure 5.20: Reflection Screen)

(figure 5.21: CIPs Responses Screen)

In addition to the above-shown functionalities, various help buttons have been added across the application, screens of all the help buttons and their popups has been appended (**Appendix 11**).

6 Testing

Testing the application was essential to ensure it met the requirements set out in the design stage and to evaluate its functionality. The testing approach involved two stages: initial unit testing to test specific units of the system, followed by functionality testing to test out the application's requirements against the acceptance criteria set out.

6.1 Unit Testing

Unit testing is a common method of testing which targets specific isolated units (a function, a module, or a section of code) of a solution and validates the unit's logic by asserting its outcome to be equivalent to the expected outcome [26].

While unit testing is suitable for testing isolated units, it should not be used (solely) to test the entirety of a given system, as a system of any notable size consists of multiple integrated units and would not be adequately tested. As such, in this project, Unit testing was used as an initial step, and to ensure the application is ready for functionality testing.

The most popular Android testing library "Junit 4" was used to write tests for various services, automated data modification, and database interactions. Specifically, Date formatting, ability level calculation, achievements score calculation, and read-write operations to Database were covered by the unit tests.

All tests asserted the correct output and **PASSED**. Signifying the application was ready for functionality testing.

6.2 Functionality Testing

Functionality testing, simply put, is verifying that the target system performs its required functions as per the acceptance criteria set out.

Each function would be performed, and the outcome perceived. If the outcome matches the expected result, the test is considered a "success", otherwise it is considered a "failure".
The requirements tested and their corresponding acceptance criteria were gathered from the requirements list identified in the design stage.

The results of the functional testing can be summarised grouped by their MoSCoW prioritisations, as such:

Requirement No.	MoSCoW	Outcome
1-49	MUST	Success
50-67	SHOULD	Success
68-71	COULD	Success
72-86	WON'T	Failure

(figure 6.1: Summary of Functional Testing Results)

The full table of requirements appended (Appendix 12).
These results have been evaluated in the following Evaluation Section.

7 Evaluation and Results

The goal of the project is to investigate whether Digital Behavioural Interventions would be viable to mitigate experiences of the Imposter Phenomenon. To do so, a DBI was created as a prototype application targeting key behaviours that sustain the IP was developed.

To achieve the goal of the project, and provide insight to the potential of DBIs, the prototype would need to be evaluated across several criteria. As such, an evaluation strategy was formed targeting several aspects as such:

Aspect	Description	Method
Functionality	Functionality of application by meeting all acceptance criteria for identified requirements.	Testing Stage composed of Unit and Funcationality Testing.
Usability	Determines the solution's ease of use, learnability, quality of support, and enjoyment.	Usability study: users asked to complete tasks and respond to a usability survey.
Imparting Familiarity	Determines the solution's success in familiarising the users to IP, its causes, effects, and behaviours.	Usability study: users asked to partake in two survey to compare the users' perceived and actual knowledge.
Engagement	Determines the users' engagement, interaction, and usage of the solution.	Usability study: analysing the logs the application gathers in the internal database after the week-long study.
Effectivenes	Determines the designed solution's effectiveness in altering the target behaviours and the subsequent effect on the users' experiences of IP.	Usability study: contrasting the users' Clance IP Scale scores at the start and end of the study.

(figure 7.1: Overview of Evaluation Strategy)

7.1 Evaluating Functionality

As seen in the testing stage, all unit tests passed and all the requirements marked with a MoSCoW priority of Must, Should, and Could have met their acceptance criteria and passed functionality testing. The requirements marked as Won't were not implemented and thus, as expected, have not met the criteria and have failed.

The results of the testing stage confirm the application meets the requirements compiled in the design stage and is therefore functional to evaluate as a proposed solution to the project's goal.

Usability study

To evaluate the remaining aspects, a usability study was conducted. The usability study consisted of two parts:

1) Part One:

   The users were given a list of tasks (**Appendix 13**) to complete across various sections and features of the application. This part of the study was to introduce the users to the application and ensure the application was correctly installed.

2) Part Two:

   First, the users were asked to complete a pre-study survey which contained a single section (Imposter Phenomenon Familiarity).

   After the survey, users were asked to use the application in a natural unmoderated setting for the duration of a week. During which, users were asked to complete several tasks (**Appendix 14**) at their own pace.

   Following the completion of the week-long study, users were asked to complete the post-study survey which contained three sections (IP Familiarity, Clance IP Scores, and Usability Survey).

   The pre and post survey studies have been appended (**Appendix 15**)

A total of 8 users who had expressed interest in the previous survey (Identifying Behaviours survey) were recruited. The participants were met across Microsoft Teams and sent the application, initiating the study. The surveys were hosted on the university's iSurvey, and the results analysed in the following sections.

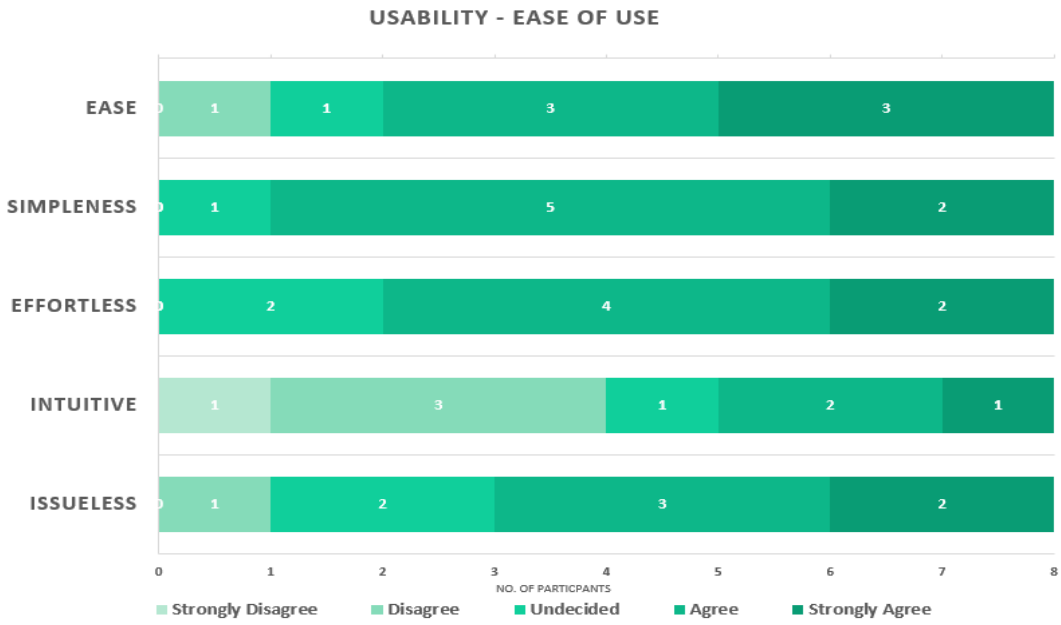
7.2 Evaluating Usability

The developed solution's usability describes its success as an application in terms of user interaction and experience. This aspect determines ease of use, learnability, support quality, and user satisfaction, all of which would encourage the use and appeal of the solution and produce a more effective outcome.

Usability was evaluated through including a usability section in the post-study survey. The section includes a survey discovered in literature [27], which in turn was created through combining several questionnaires across various dimensions of usability typically used in various literature. The implemented questionnaire was used to evaluate the usability of an application targeting anxiety in youth, and due to the similar nature between the applications, this usability questionnaire was deemed adequate to use.

The responses of the participants were as such:

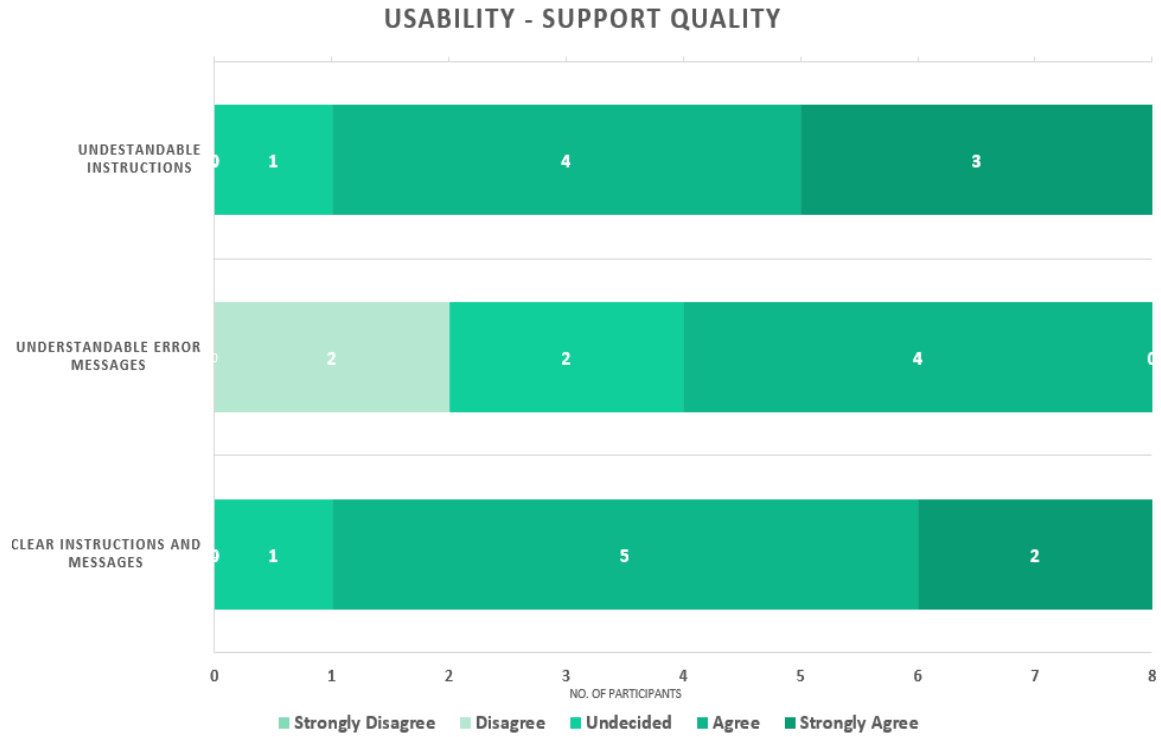
1) Ease of System Use:



(figure 7.2: Post-Study Survey: Usability Section - Ease of Systems Use Participants Responses)

As seen in figure, the users generally had great feedback, with most users agreeing with the system's ease of use. A notable downturn noted is intuitiveness, which is understandable given the complex goals of the application and its integrated features, considerations must be taken to further reduce the convoluted nature of the application.

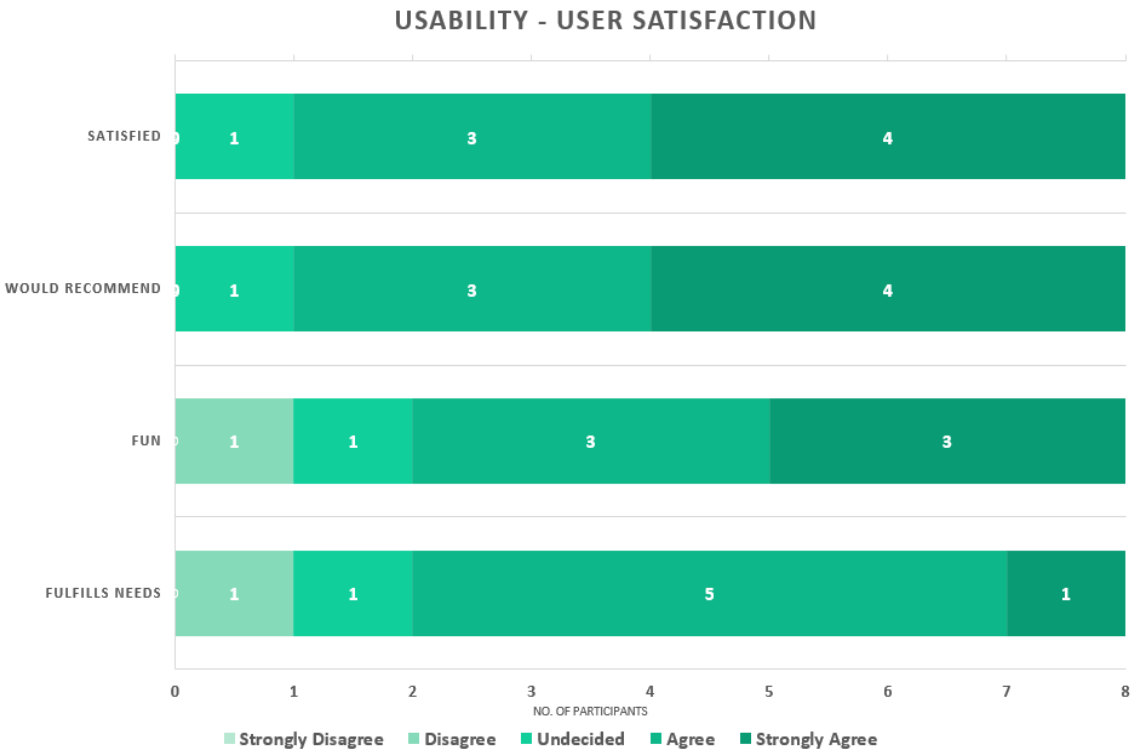
2) Support Quality:



(Figure 7.3: Usability Section – Support Quality Participants Responses)

As seen in the figure, most of the users found the support dialog to be understandable, with a small exception. After reaching out for further feedback, the users who disagreed indicated that they have not encountered any error messages, and thus disagreed. This is due to error messages only triggering on a few occasions, so it was rarely needed.

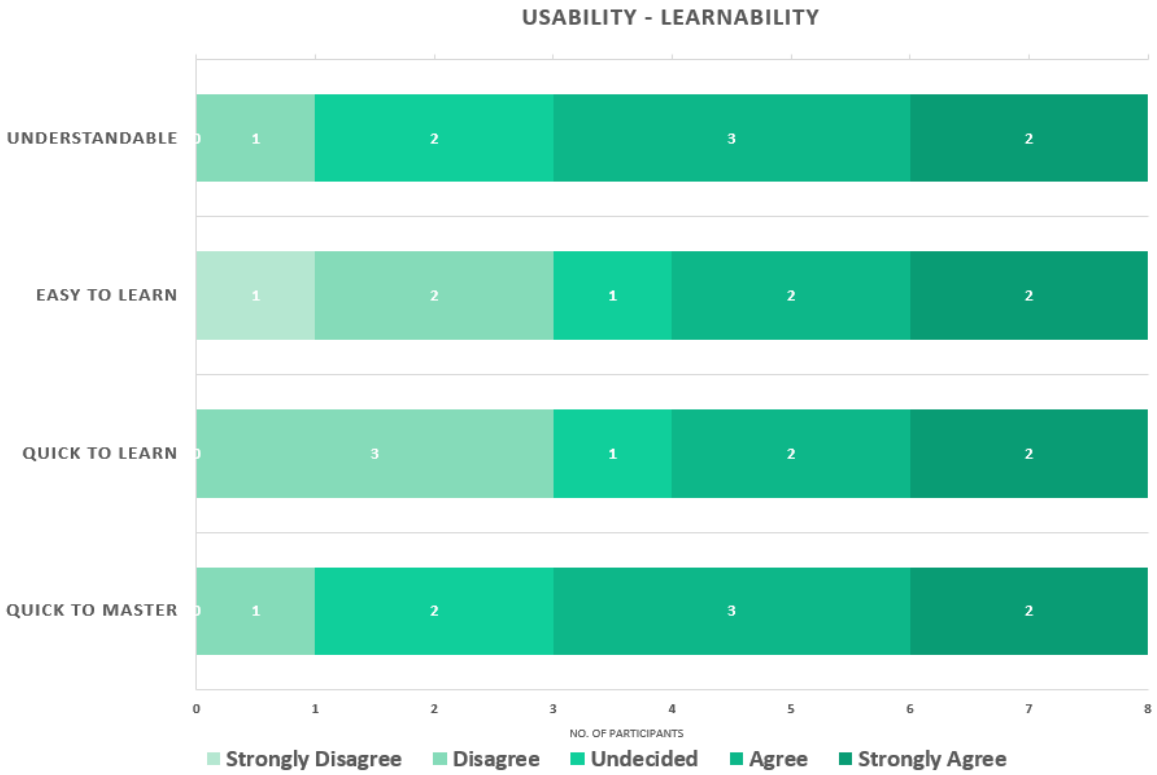
3) User Satisfaction:



(Figure 7.4: Post-Study Survey: Usability Section –User Satisfaction Participants Responses)

As seen, most users agreed that the application was satisfying, fun, fulfilled their needs, and overall, they would recommend the application to others. A single user disagreed about the application being fun or fulfilling their needs. This user demonstrated a low Clance IP Score, and as such experienced very little, if any, Imposterism. This seems to indicate that the application requires intrinsic motivation from the users, and an internal need to address their Imposterism, otherwise they would find the application cumbersome and unnecessary.

4) Learnability:



(figure 7.5: Post-Study Survey: Usability Section – Learnability Participants Responses)

Users were split on the system's learnability, with around half the users responding it was not easy or quick to learn. When reaching out to the users, most clarified this was due to the large amount of content to tackle. While efforts have been taken to separate the features across tabs, more effort could be put into sequentially unlocking the sections and features to avoid overloading the users.

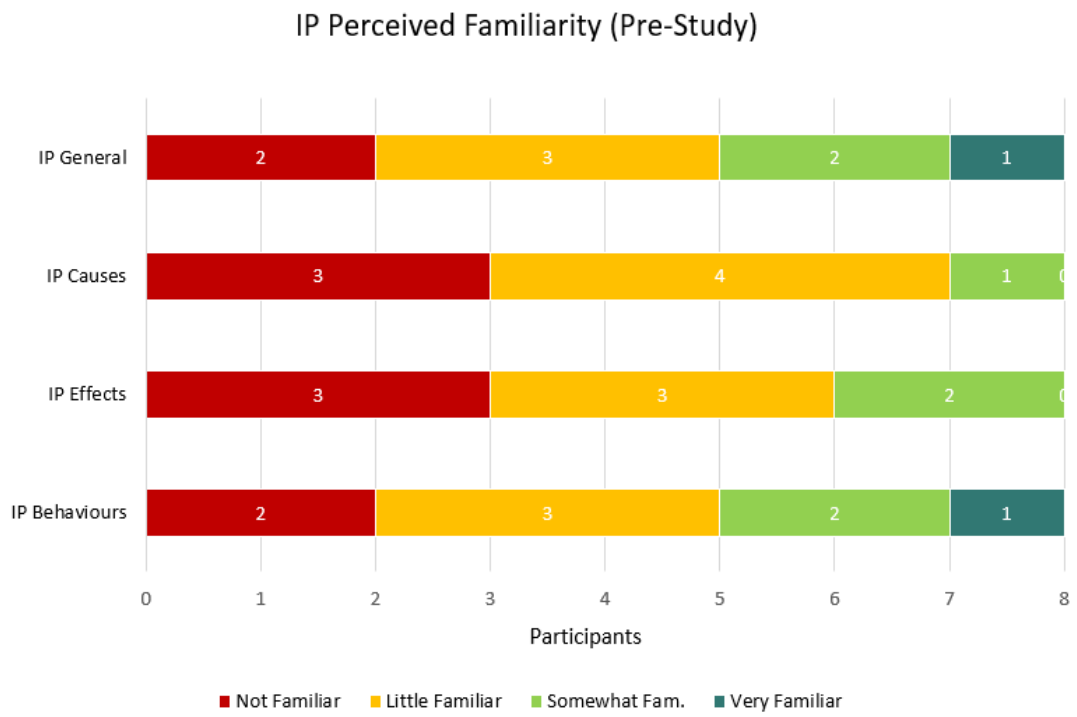
7.3 Evaluating Imparting Familiarity

Ensuring the user would gain familiarity with the Imposter Phenomenon and its details has been identified as a central goal of the solution and vital to the success of the intervention plan. As such, evaluating whether the solution imparted a level of familiarity was essential.

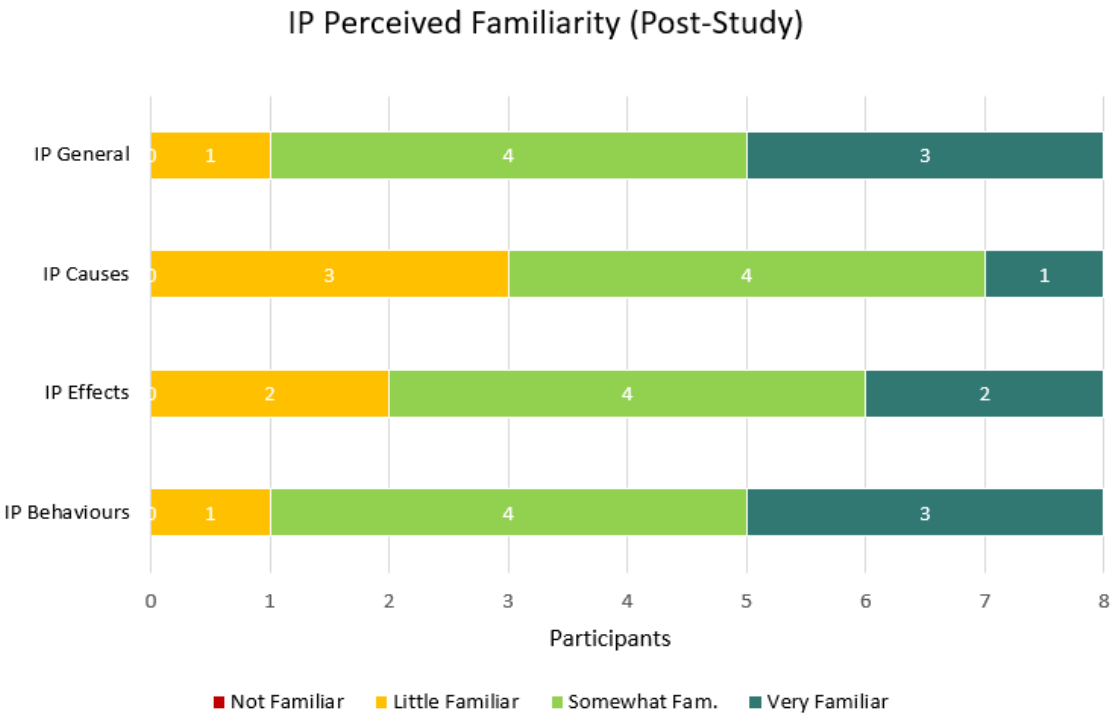
This evaluation was done by including an IP familiarity section in both surveys designed to contrast the user's familiarity with IP, its causes, effects, and behaviours before and after the study.

The section would include questions asking the users to describe their own familiarity to IP, its causes, effects, and behaviours to establish their level of "perceived" familiarity. Followed by asking the user to classify example scenarios, types, effects, and behaviours as either correlated to IP or not. This would determine the user's "actual" familiarity.

The results of the users' perceived familiarity were:



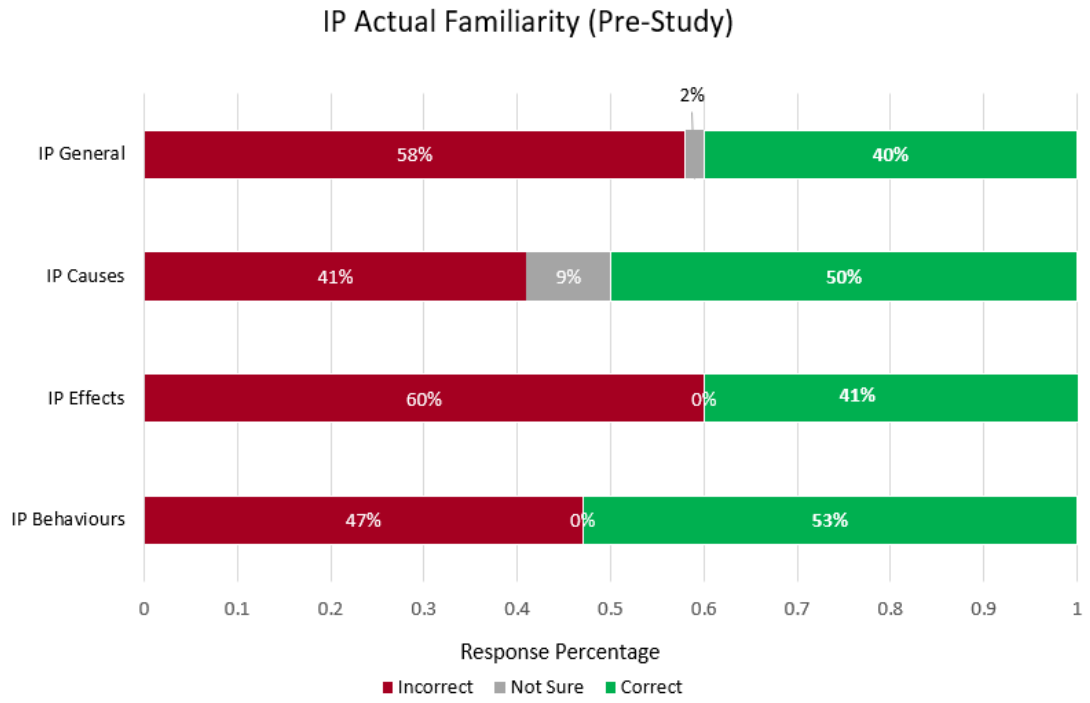
(figure 7.6: Pre-Study Survey: IP Familiarity Section – Perceived Familiarity Participants Responses)



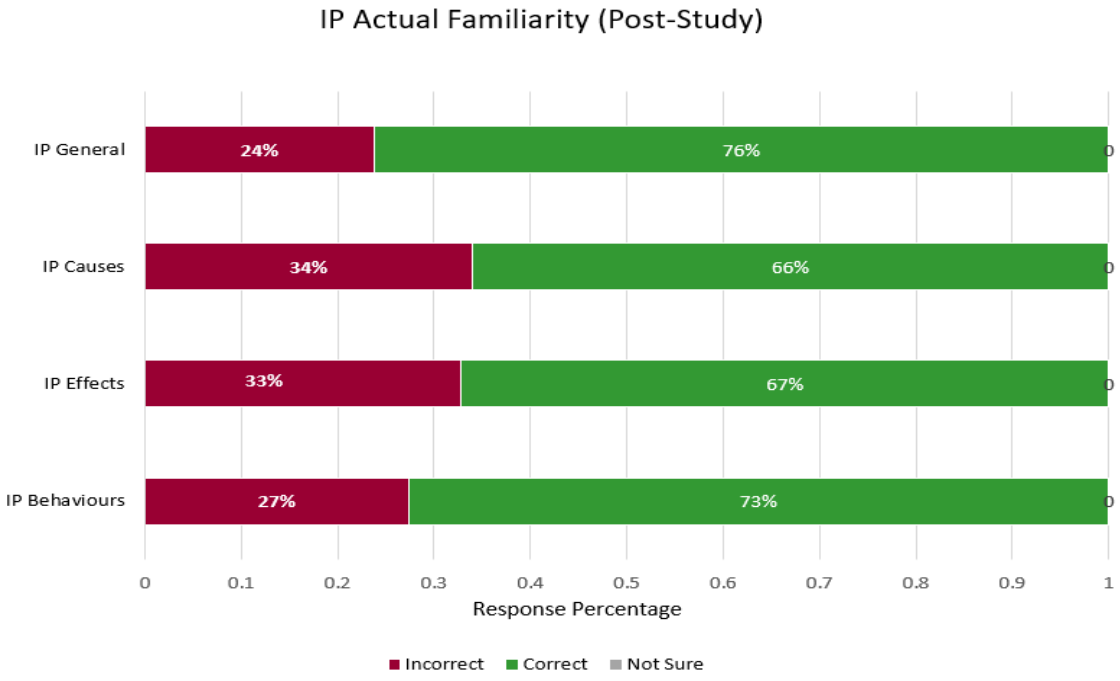
(figure 7.7: Post-Study Survey: IP Familiarity Section – Perceived Familiarity Participants Responses)

As noted through comparing both figures, users gained a notable confidence with their familiarity to IP. Initially, more than half the users have stated they had little or no familiarity with IP. Whereas after the study, a large majority of users stated they are somewhat or very familiar with IP.

As for the users' actual familiarity:



(figure 7.8: Pre-Study Survey: IP Familiarity Section –Actual Familiarity Participants Responses)



(figure 7.9: Post-Study Survey: IP Familiarity Section –Actual Familiarity Participants Responses)

As noted in the figures, there is a notable increase in correct answers, and users were able to correctly identify more cases, causes, effects and behaviours of IP after using the application. The mean of correct answers rose from 46% to 70.5% (an improvement of 24.5%), while the mean of incorrect answers dropped from 51.5% to 29.5% (a drop of 22.0%).

These results indicate a rise in confidence as well as successful imparting in familiarity of IP, its effects, causes, and behaviours.

7.4 Evaluating Engagement

Another central goal of the developed solution was to ensure it would be engaging, and that the users would consistently and persistently engage with the application and its various features.

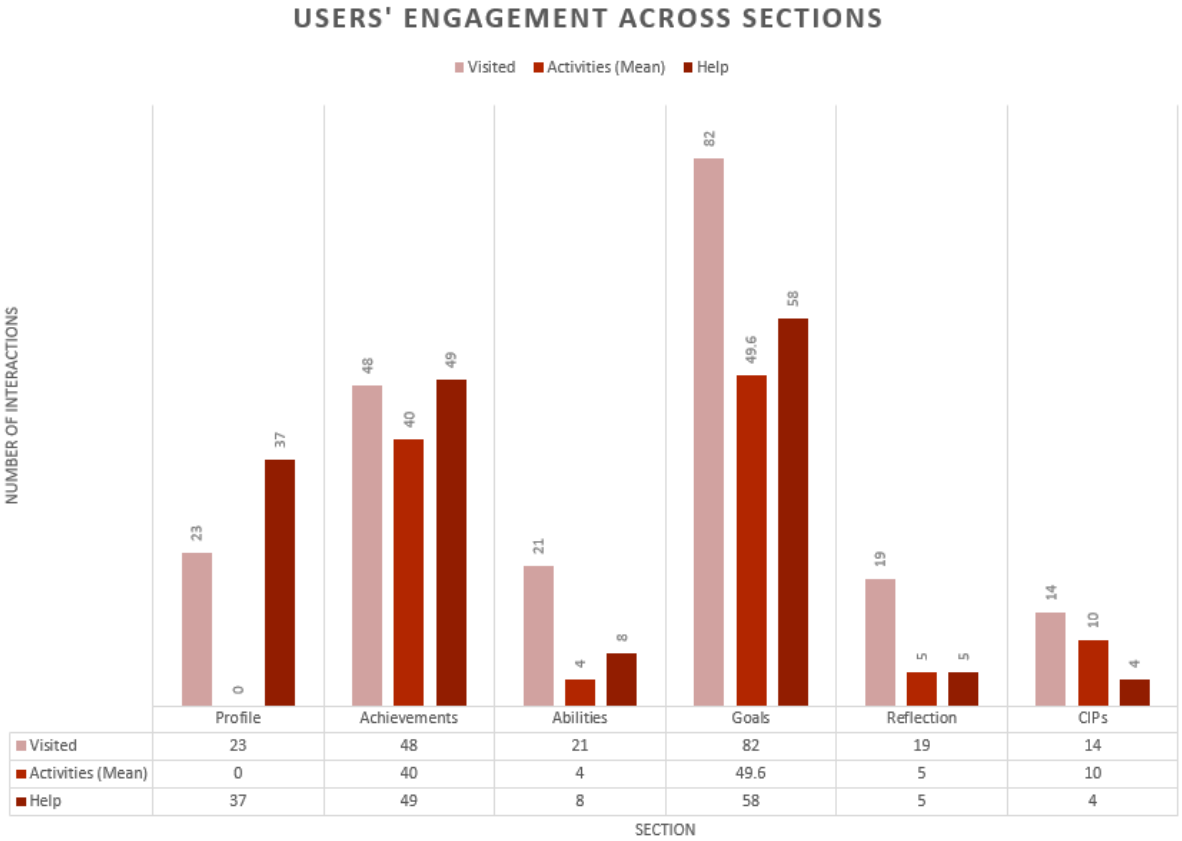
Just as with usability, solid engagement would lead to a more effective solution and therefore a produce a more viable treatment plan.

As such, engagement was gauged through analysing log entries saved by the application in the internal database logging the users' usage.

The results of this analysis were as such:

1) The application was started a total of 203 times across the week by all 8 users, with a mean of (25.375/week) and (3.625/day) starts per user. This indicates the application was used frequently and consistently across the duration of the usability week.

2) The users' interactions with the various sections, activities, and help buttons were recorded as such:



	Profile	Achievements	Abilities	Goals	Reflection	CIPs
Visited	23	48	21	82	19	14
Activities (Mean)	0	40	4	49.6	5	10
Help	37	49	8	58	5	4

(figure 7.10: Summary of Users' Logged Engagement with the application)

Note: Activities (Mean) indicates the number of interactions with all the activities within a section divided by the number of activities within that section. This will vary largely across sections (example: profile contains no activities, therefore has a mean of 0), but would still provide indication of engagement with the sections.

As noted, the most popular section was goals, followed by achievements. This is reasonable, as the goals section can be considered the "central" aspect of the application, offering several activities, and integrating into most other sections in some way (adding achievements, growing abilities, and reflections).

The Reflection and CIPs sections observed less engagement, which was expected as they can be considered auxiliary sections mainly used to track past activities.

A notable drop in engagement can be noticed in the Abilities section, this could be attributed to the section not containing any activities besides viewing, relying instead on goals to improve and progress the abilities.

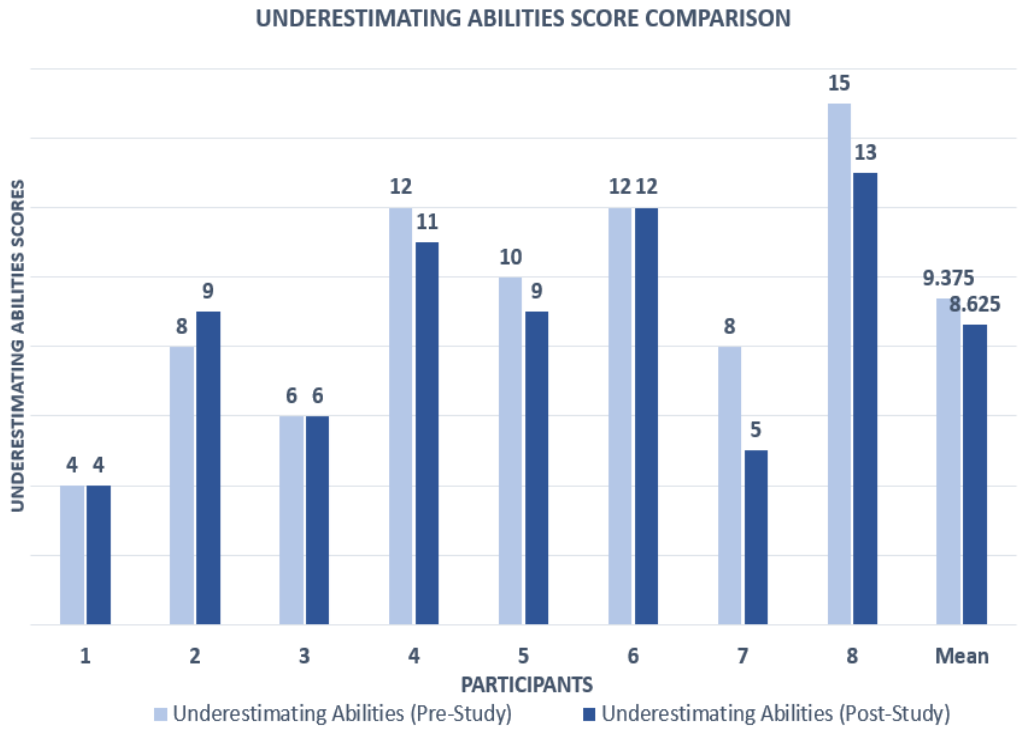
Overall, the engagement evaluation suggests the application was consistently used, and various sections were engaged with to appropriate levels, with possible room for improvement in the Abilities section.

7.5 Evaluating Effectiveness

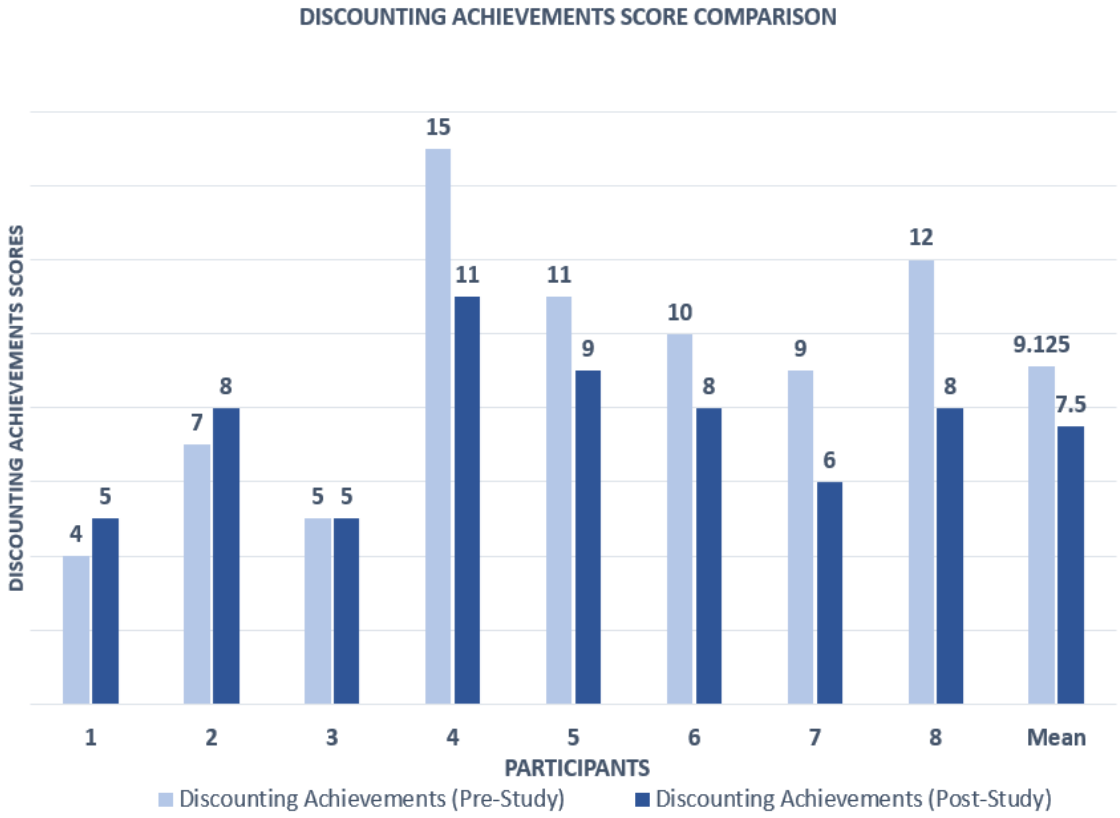
The final aspect to evaluate, and perhaps the most important, is the developed solution's effectiveness. This aspect evaluates whether the developed solution offers a viable, successful, and effective treatment to alter the target behaviours, and subsequently lessens the user's experience of Imposter Phenomenon.

To evaluate effectiveness, users were asked to answer another Clance IP Scale (CIPs) questionnaire within the application at the end of the study. These scores, along with the users' initial setup CIPs scores were then compared as such:

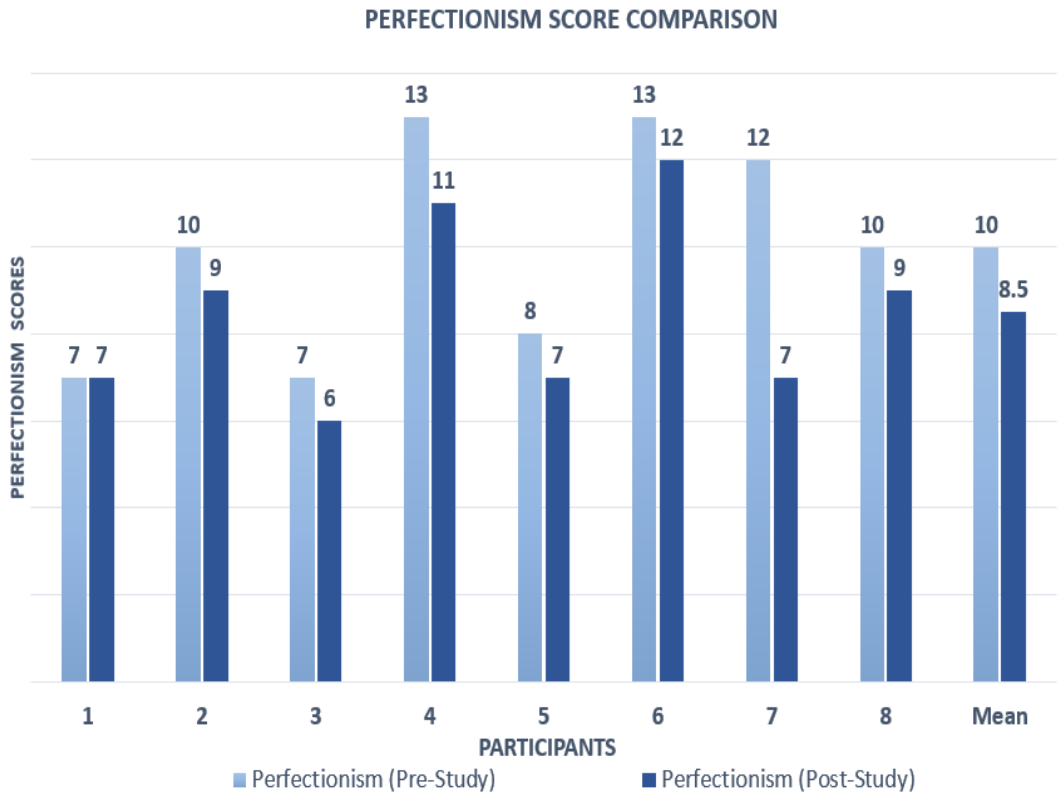
1) Target Behaviours:



(figure 7.11: Comparison of Users' Underestimating Abilities Scores Pre and Post Study)



(figure 7.12: Comparison of Users' Discounting Achievements Scores Pre and Post Study)



(figure 7.13: Comparison of Users' Perfectionism Scores Pre and Post Study)

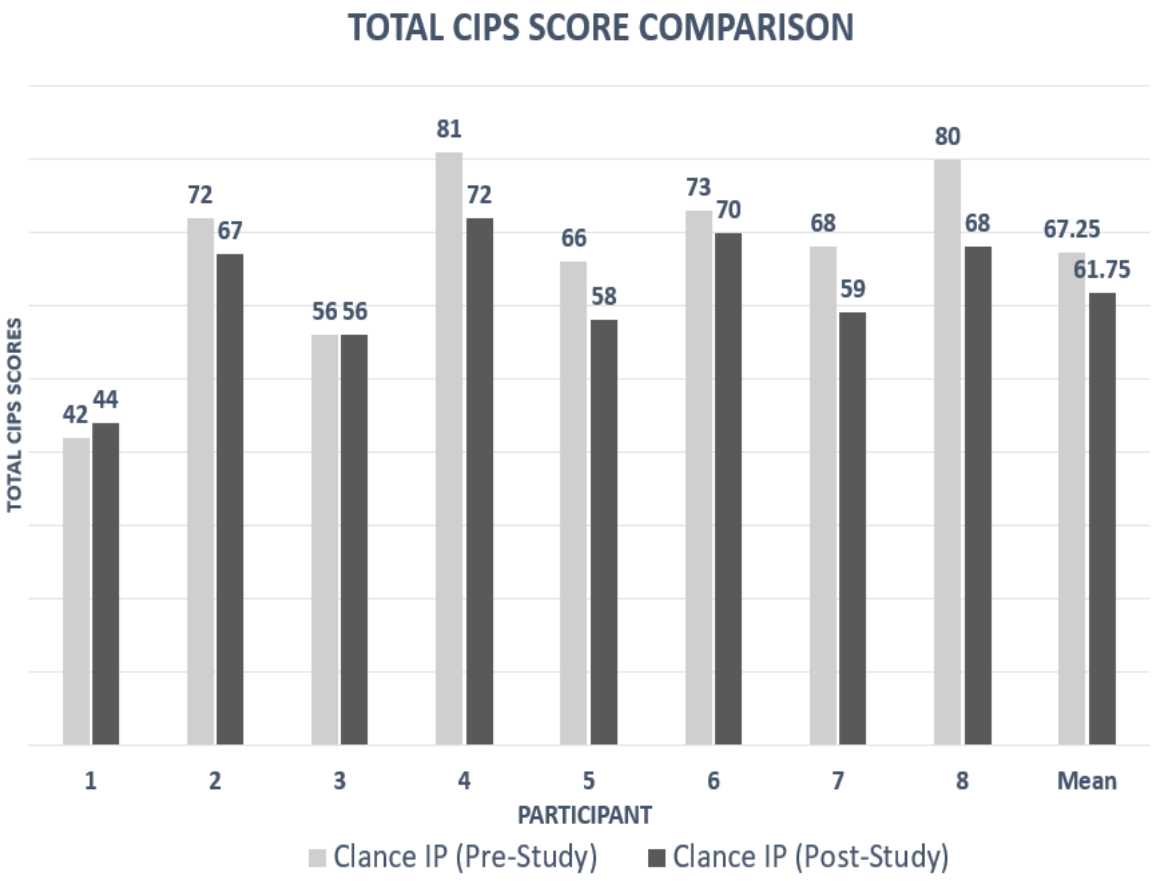
The comparison can be summarised according to the table:

Behaviours	User Change	Pre-Study Mean	Post-Study Mean	Mean Change
Underestimating Abilities	Drop: 4 Users No Difference: 3 Users Increase: 1 User	9.375	8.625	0.75 (5%)
Discounting Achievements	Drop: 5 Users No Difference: 1 User Increase: 2 Users	9.125	7.5	1.625 (10.8%)
Perfectionism	Drop: 7 Users No Difference: 1 User Increase: 0 User	10	8.5	1.5 (10%)
Total:	-	28.5	24.625	3.875 (8.6%)

(figure 7.14: Comparison of Targeted Behaviours Mean Scores Pre and Post Study)

As seen, most users demonstrated a drop across each target behaviour. With the total average across behaviours dropping from 28.5 points to 24.625, a total drop of 3.875 (8.6%). Suggesting a notable alteration across the target behaviours.

2) Total CIPs Comparison:



(figure 7.15: Comparison of Users' Total CIPs Scores Pre and Post Study)

A total of six users demonstrated a drop across their total CIPs Score, while one user showed no difference and one user showed a minor increase. The total average dropped from 67.25 to 61.75, a difference of 5.5 points (5.5%).

All the above results seem to indicate an overall drop in both IP, and the various behaviours for most users of the application, with a small exception.

It is important to note that these results stem from a usability study that lasted only a week and involving eight users, and therefore, may not present an accurate assessment of long-term and durable effectiveness. As such, a more in-depth and rigorous evaluation would be necessary to produce more accurate results over the full extent of the solution's effectiveness.

7.6 Results

The results of the evaluation stage indicate the application is functional in meeting the allotted acceptance criteria, usable despite some difficulty in intuitiveness and learnability, engaging with the minor exception of the Abilities section, and successful in imparting the users with considerable confidence and familiarity Imposter Phenomenon and its various details.

In addition, the results indicate that the application has a minor yet notable effect on lessening an individual's experience of Imposter Phenomenon, and in altering the behaviours that sustain IP within an individual. With an imparting note that a longer and more in-depth usability study recruiting more users could yield more accurate and informing results.

Altogether, the purpose of this evaluation was to evaluate the developed application across several aspects in order to explore the potential the application (and Digital Behavioural Interventions in general) could have on alleviating and mitigating experiences of the Imposter Phenomenon within individuals.

To which, the results offer valuable insight to the tangible and promising potential of the application and DBIs in mitigating experiences of the Imposter Phenomenon within an individual. Thereby successfully meeting the goals of this individual project.

8 Future Work and Conclusion

8.1 Future Work

As the project was limited by time and resources, and only a prototype of a potential solution was designed, several items were identified which were not feasible to implement but could be considered in future implementations and might lead to an overall more successful application.

During the design stage, several requirements were gathered and given a MoSCoW prioritisation of Won't. These requirements were identified at the time as possible implementations for future work.

The first requirement is a notifications system that would encourage users to use the application more frequently. These notifications would need to be carefully designed to ensure they do not overload or annoy the user but could lead to a notable increase in engagement and system use.

Another requirement would be to sequentially unlock the various sections and features of the application and offer a guided tutorial that would be prioritised based on the user's score across the target behaviours. This would handle the overload of content available all at once, an issue which was detected during evaluation, and would lead to a more intuitive and learnable application.

The last requirement identified was implementing a social aspect. The Persuasive Systems Design framework describes using social elements in the treatment plan to lead to a more effective overall behavioural change. A possible implementation of this could be through allowing trusted peers, supervisors, or specialists access to the user's plan and activities on the application and allow them to directly comment or offer guidance to the user. If implemented properly, this could aid the user through the course of the treatment plan.

The last potential for future work lies in the evaluation. While the conducted evaluation was able to produce results that determine the success of the established goals of the individual project, a longer and more in-depth evaluation would produce more reliable and significant results that would demonstrate the full extent of the application (and Digital Behavioural Interventions in general) in alleviating the Imposter Phenomenon within individuals.

8.2 Conclusion

In conclusion, the goal of the individual project was to explore whether Digital Behavioural Interventions would be viable in reducing an individual's experiences of the Imposter Phenomenon.

To undertake this goal, the project followed a waterfall approach in its sequential stages: Initially, background reading and preparation was completed, followed by a design stage where key behaviours that sustain IP within an individual were identified through a study. An intervention plan was then created targeting these behaviours, which was then digitised into a design of a smartphone application.

This application was then developed using Agile techniques and tools, and subjected to Unit and Functionality testing, both of which signified the application as functional. A usability study was then undertaken to evaluate several aspects of the developed solution. These aspects include usability, imparting familiarity of IP, engagement, and effectiveness.

The results of the evaluation were then compiled, indicating the application as largely successful across several benchmarks, with a few notable exceptions and suggestions for improvements, and a note specifying the need for a more in-depth evaluation to produce more substantial results.

Overall, the results indicate that the project has met its goal with a positive outcome. Gaining insight into the viability of Digital Behavioural Interventions and identifying the clear potential they could have on alleviating key behaviours that sustain experiences of the Imposter Phenomenon within an individual.

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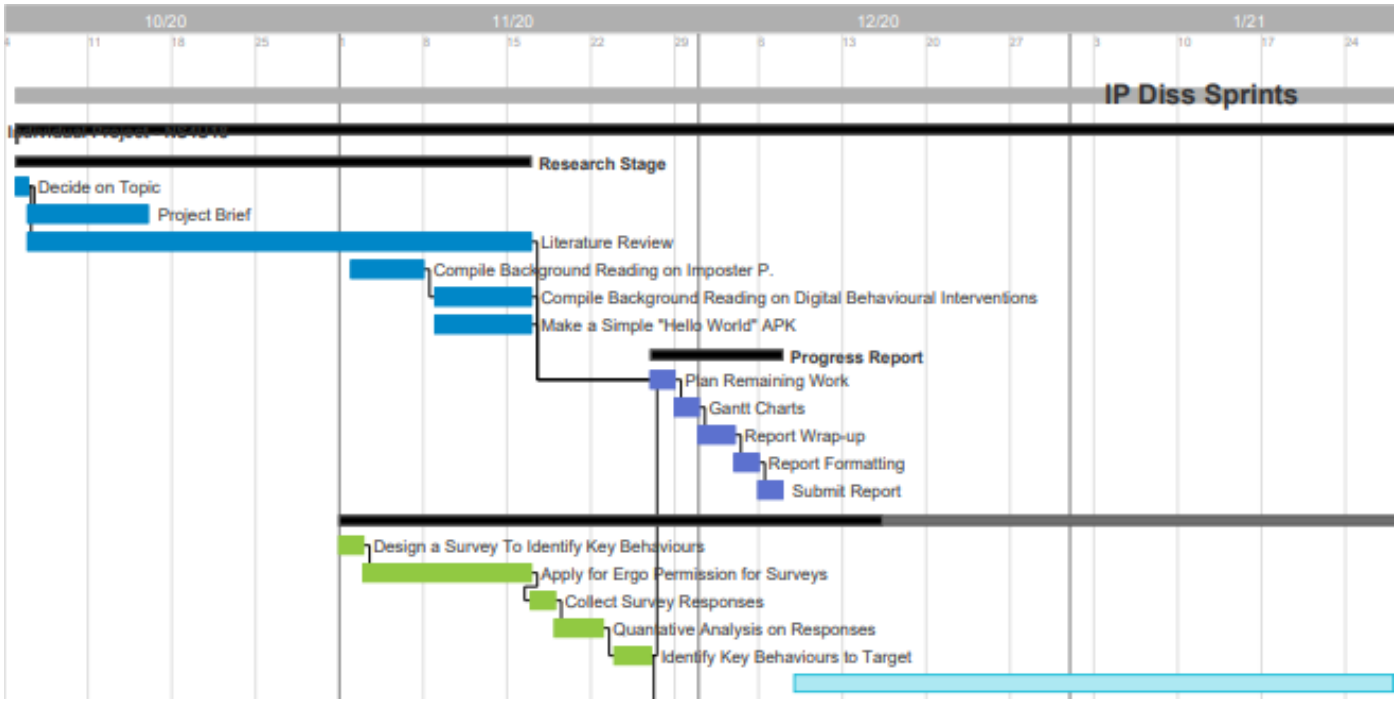
10 Appendix

Appendix List:

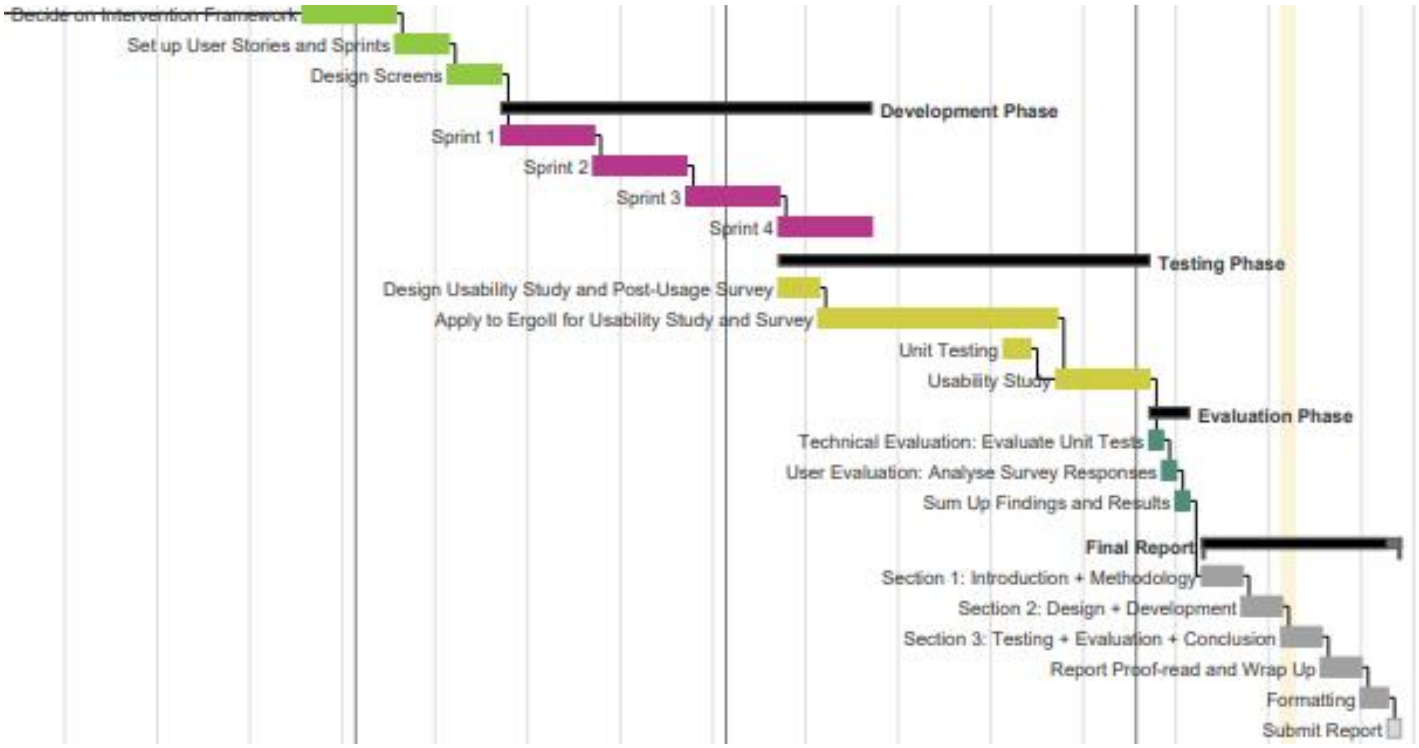
No.	Appendix Name
1-1	Initial Gantt Chart – First Semester
1-2	Initial Gantt Chart – Second Semester
2-1	Final Project Gantt Chart – First Semester
2-2	Final Project Gantt Chart – Second Semester
3	Copy of the Digitised CIPs Survey used for the Characteristics Study
4	Subscale and Grouping of CIPs items into the investigated subscales.
5	PSD Postulations
6	Abilities used in the Abilities Section
7	PSD Software Features and subsequent implementations in the system
8	Burndown Chart
9	User Stories Sprint Plan Split
10	Achievement Types and Scores
11	Application Help Popups Screens
12	Functionality Testing Full Results
13	Usability Study Part 1 Tasks
14	Usability Study Part 2 Tasks
15	Usability Study Post-Survey Questionnaire

Appendix

1) Appendix 1-1: Initial Gantt Chart – First Semester

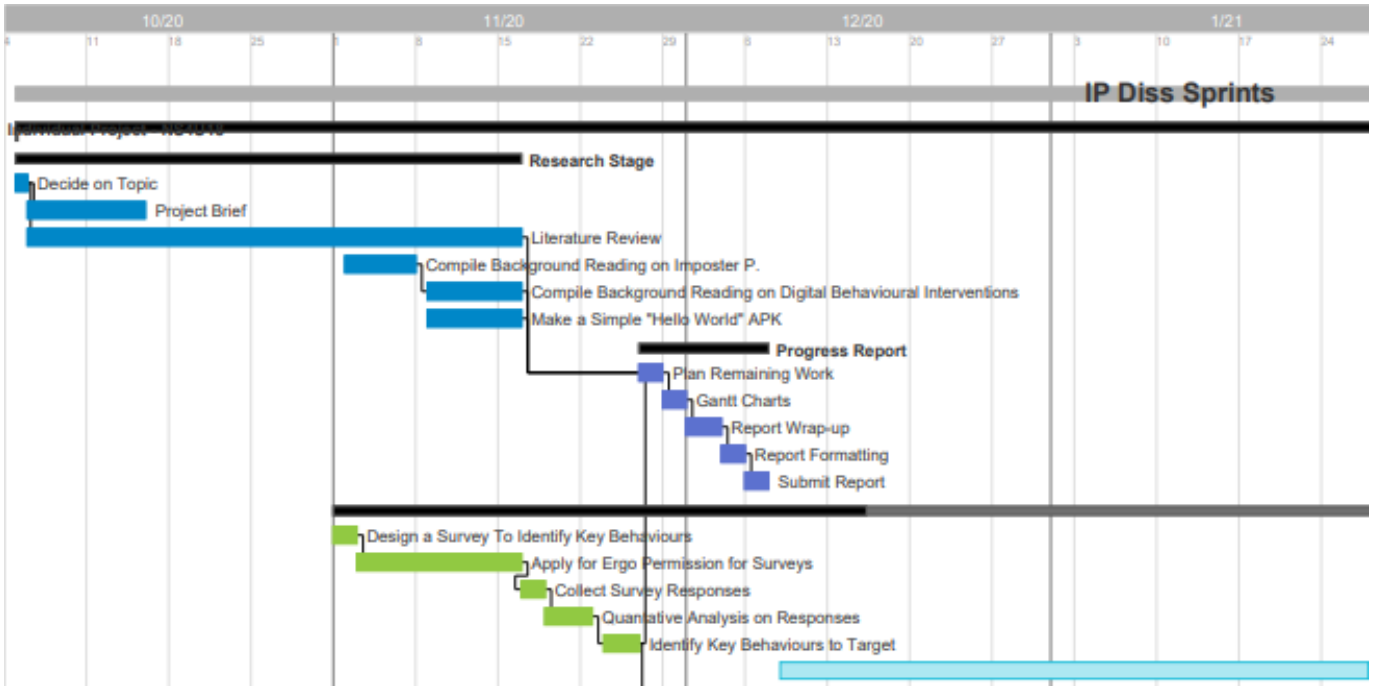


Appendix 1-2: Initial Gantt Chart – Second Semester

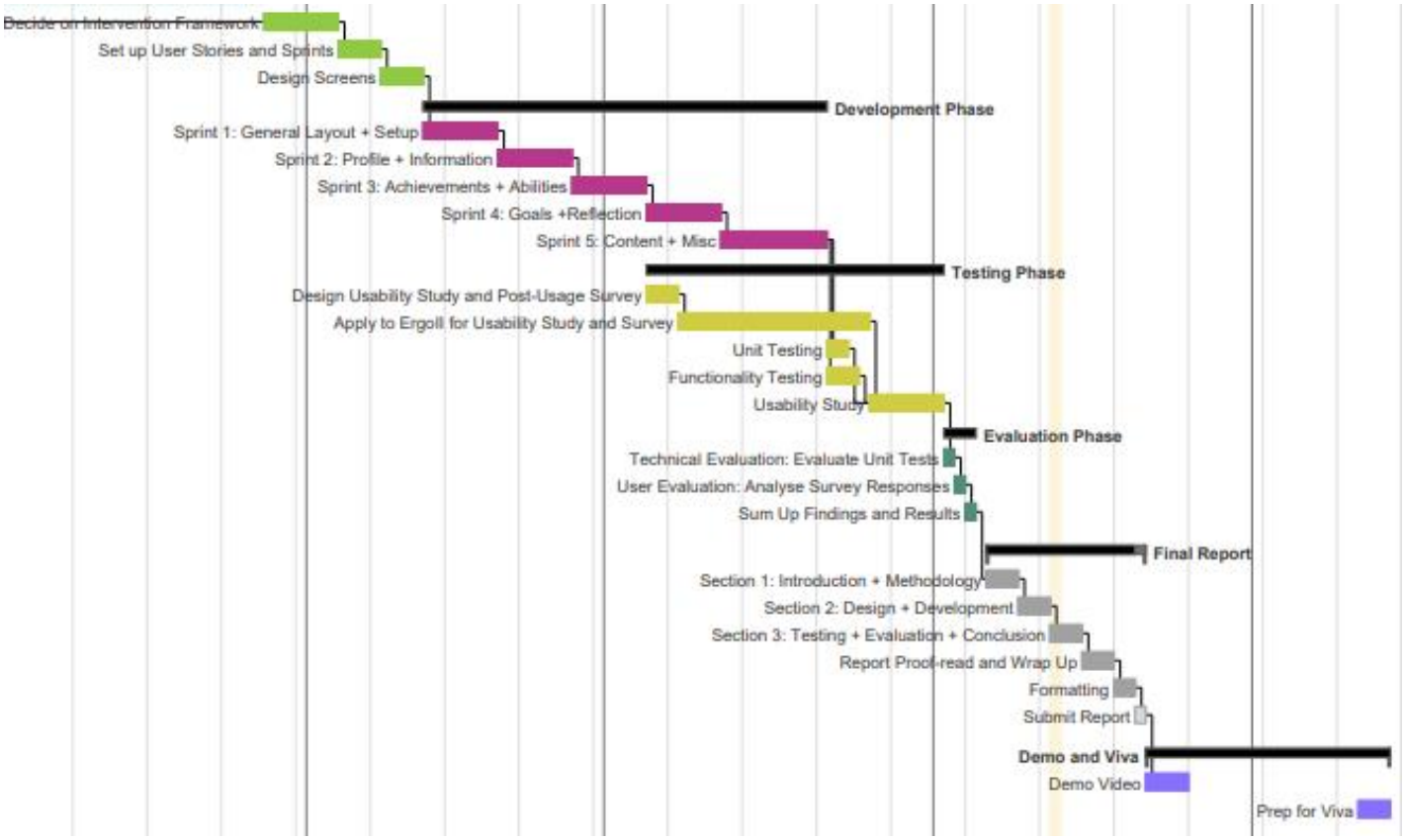


Appendix

2) Appendix 2-1: Final Project Gantt Chart – First Semester



Appendix 2-2: Final Project Gantt Chart – Second Semester



3) Appendix 3: Copy of the Digitised CIPs Survey used for the Characteristics Study:

Imposter Phenomenon Test

Hello,

This is a simple survey that intends to measure the scale of the Imposter Phenomenon of its participants.

For each question, it is best to give the first answer that comes to mind, rather than dwelling on the statement.

Adding email is completely optional, but would be highly appreciated in the case I would need to reach out for further questions!

You can calculate the results at the end of the survey, keep track of the points and add them up before at the end **BEFORE SUBMITTING** to see your result!

Section 1. Further Studies

Feel free to skip this section to remain anonymous, but leaving details for future contact will be extremely appreciated!

Question 1.1

Would you like to take part in further studies?

- ○ Yes
- ○ No

Question 1.1b

If yes, what is your University e-mail address?

Section 2. Imposter Phenomenon Scale

This section consists of 20 statements, please select the option that best indicates how true the statement is for you. It is best to give the first response that comes to mind.

Question 2.1

1. I have often succeeded on a test or task even though I was afraid that I would not do well before I undertook the task.

- ○ 1 - Not at all true
- ○ 2 - Rarely

Appendix

- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.2

2. I can give the impression that I'm more competent than I really am.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.3

3. I avoid evaluations if possible and have a dread of others evaluating me.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.4

4. When people praise me for something I've accomplished, I'm afraid I won't be able to live up to their expectations of me in the future.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.5

5. I sometimes think I obtained my present position or gained my present success because I happened to be in the right place at the right time or knew the right people.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.6

6. I’m afraid people important to me may find out that I’m not as capable as they think I am.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.7

7. I tend to remember the incidents in which I have not done my best more than those times I have done my best.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.8

8. I rarely do a project or task as well as I’d like to do it.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.9

9. Sometimes I feel or believe that my success in my life or in my job has been the result of some kind of error.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.10

10. It’s hard for me to accept compliments or praise about my intelligence or accomplishments.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○

Appendix

15. When I've succeeded at something and received recognition for my accomplishments, I have doubts that I can keep repeating that success.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.16

16. If I receive a great deal of praise and recognition for something I've accomplished, I tend to discount the importance of what I've done.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.17

17. I often compare my ability to those around me and think they may be more intelligent than I am.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.18

18. I often worry about not succeeding with a project or examination, even though others around me have considerable confidence that I will do well.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.19

19. If I'm going to receive a promotion or gain recognition of some kind, I hesitate to tell others until it is an accomplished fact.

- ○ 1 - Not at all true

3 - Sometimes

- ○ 4 - Often
- ○ 5 - Very true

Question 2.11

11. At times, I feel my success has been due to some kind of luck.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.12

12. I'm disappointed at times in my present accomplishments and think I should have accomplished much more.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.13

13. Sometimes I'm afraid others will discover how much knowledge or ability I really lack.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.14

14. I'm often afraid that I may fail at a new assignment or undertaking even though I generally do well at what I attempt.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.15

Appendix

- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.20

20. I feel bad and discouraged if I'm not "the best" or at least "very special" in situations that involve achievement.

- ○ 1 - Not at all true
- ○ 2 - Rarely
- ○ 3 - Sometimes
- ○ 4 - Often
- ○ 5 - Very true

Question 2.21

Add up your points here if you want to calculate the result in the next page!

(1 -> 40 Or Less)

(2 -> 41 - 60)

(3 -> 61-80)

(4 -> 80 or More)

4) Appendix 4: Subscale and Grouping of CIPs items into the investigated subscales.

Subscale / Grouping	Question Number	Question
Fake – Underestimating Abilities	1	I have often succeeded on a test or task even though I was afraid that I would not do well before I undertook the task.
	17	I often compare my ability to those around me and think they may be more intelligent than I am.
	18	I often worry about not succeeding with a project or examination, even though others around me have considerable confidence that I will do well.
Fake – Fear of Unmasking	2	I can give the impression that I'm more competent than I really am.
	3	I avoid evaluations if possible and have a dread of others evaluating me.
	6	I'm afraid people important to me may find out that I'm not as capable as they think I am.
	13	Sometimes I'm afraid others will discover how much knowledge or ability I really lack.
Discount – Fear of Future Failure	4	When people praise me for something I've accomplished, I'm afraid I won't be able to live up to their expectations of me in the future.
	14	I'm often afraid that I may fail at a new assignment or undertaking even though I generally do well at what I attempt.
	15	When I've succeeded at something and received recognition for my accomplishments, I have doubts that I can keep repeating that success.
	19	If I'm going to receive a promotion or gain recognition of some kind, I hesitate to tell others until it is an accomplished fact.
Discount – Acknowledgement	10	It's hard for me to accept compliments or praise about my intelligence or accomplishments.
	12	I'm disappointed at times in my present accomplishments and think I should have accomplished much more.
	16	If I receive a great deal of praise and recognition for something I've accomplished, I tend to discount the importance of what I've done.
Perfectionism	7	I tend to remember the incidents in which I have not done my best more than those times I have done my best.
	8	I rarely do a project or task as well as I'd like to do it.
	20	I feel bad and discouraged if I'm not "the best" or at least "very special" in situations that involve achievement.
Luck	5	I sometimes think I obtained my present position or gained my present success because I happened to be in the right place at the right time or knew the right people.
	9	Sometimes I feel or believe that my success in my life or in my job has been the result of some kind of error.
	11	At times, I feel my success has been due to some kind of luck.

5) Appendix 5: PSD Postulations

Postulation	Definition	Considerations in IP Intervention Plan
IT is never neutral	Persuasive system should be adaptable to changing goals of the user	This can be implemented by accounting for different goals across the different target behaviours.
Consistency	The system must encourage commitment and consistency. Users can be persuaded to be more committed after an initial large step.	Commitment and Persuasion could be induced by including a Setup section at first usage. Setup would include a digitised Clance IP Scale survey, which would calculate the severity of the user's target behaviours and prioritise them as such. As for consistency: the initial assigned plan must be static, and not change massively back and forth.
Incrementality	Do not present the intervention as a single point. Instead split it across content and unlock content slowly across progress.	This can be done by separating the application into clear tabs, each with a clear goal and scope. A possible addition could be unlocking the tabs sequentially.
Routes	Offer both Direct and Indirect of accessing the treatment.	Direct route would be by being fully transparent and describing the planned intervention to the user, as well as allowing the user to view the plan at any time. Indirect route would be through using techniques to reduce information overload and ease the user's ability across the treatment.
Usefulness and ease	Ensure the system is easy to use, learnable, and useful.	Design the solution with familiar and intuitive mechanisms that are popular across modern smartphone applications.
Unobtrusiveness	avoid disturbing users when fulfilling the systems primary task.	This can be done by avoiding by overloading the user, avoiding forced popups, or cluttering the current focused activity.
Transparency	The persuasive system must be open, and all persuasions must be transparent to the user.	Allow full transparency of the system, by explaining every functionality and its purpose.

Appendix

6) Appendix 6: Abilities used in the Abilities Section

ID	Name	Details	Methods of Improvement
1	Memorization	Ability to remember information, such as: words, numbers, pictures, and procedures.	Mnemonic Devices, Relate Information, Structure and Organise Data, Constant Learning
2	Problem Solving	Ability to understand and organize a problem and then to select a method and come up with logical solutions.	Real-World Applications, Practice, Understand Concepts, Solidify Basics
3	Comprehension	Ability to understand spoken and written words and sentences.	Use Context, Summarise, Vocabulary Training, Note-Taking
4	Concentration	Ability to concentrate on a task one is doing.	Single Tasking, Meditation, Reduce Interference
5	Visualisation	Ability to imagine how something will look when it is moved around or when its parts are moved or rearranged.	Exercise Mental Imagery, Explore Creative Outlets, Observe Details, Mentally Breakdown Objects
6	Communication	Ability to learn and understand and communicate with another person.	Active Listening, Concise and Clear Speech, Vocabulary Training, Team-Work Exercises
7	Time Management	Ability to organize and plan how to divide one's time between specific activities and tasks.	Task Prioritisation, Goal-Setting Theory, Avoid Procrastination
8	Self-Reflection	Ability to exercise introspection and to attempt to learn more about one's nature and essence.	Meditation, Journaling, Analyse Past Outcomes, Apply Results to Future Goals.

7) Appendix 7: PSD Software Features and subsequent implementations in the system

Category	**Design Principles**	**Implementation in the Designed Solution**
Primary Task Support	Reduction: Simplify Tasks	Each activity will be localised to have a sole outcome (e.g.: Adding goal, viewing an achievement… etc)
	Tunnelling: Guide users through experience	Add Popup Helpers to guide users through various activities
	Tailoring: Tailor the system to the user's needs.	Prioritising the target key behaviours based on the user's setup results.
	Personalisation	Include a profile section.
	Self-monitoring	Past goals, reflections, achievements, abilities, and any taken CIPs (Clance IP Scale survey) will be recorded for the user to view.
Computer-human dialogue support	Praise	Offer praise and encouraging language across activities.
	Reward	Add scores to achievements, experience to abilities, and gradual information unlock
	Suggestion	Offer hints and suggestions throughout activities, through popup helpers and by offering examples (achievement types, ways to improve abilities… etc)
Perceived System Credibility	Trustworthiness	Provide true and unbiased information
	Expertise	Provide expert information based on research
	Verifiability	Provide sources for all listed information, with links to follow up on sources.
Social Support	-	Left for future work.

8) **Appendix 8: Burndown Chart**

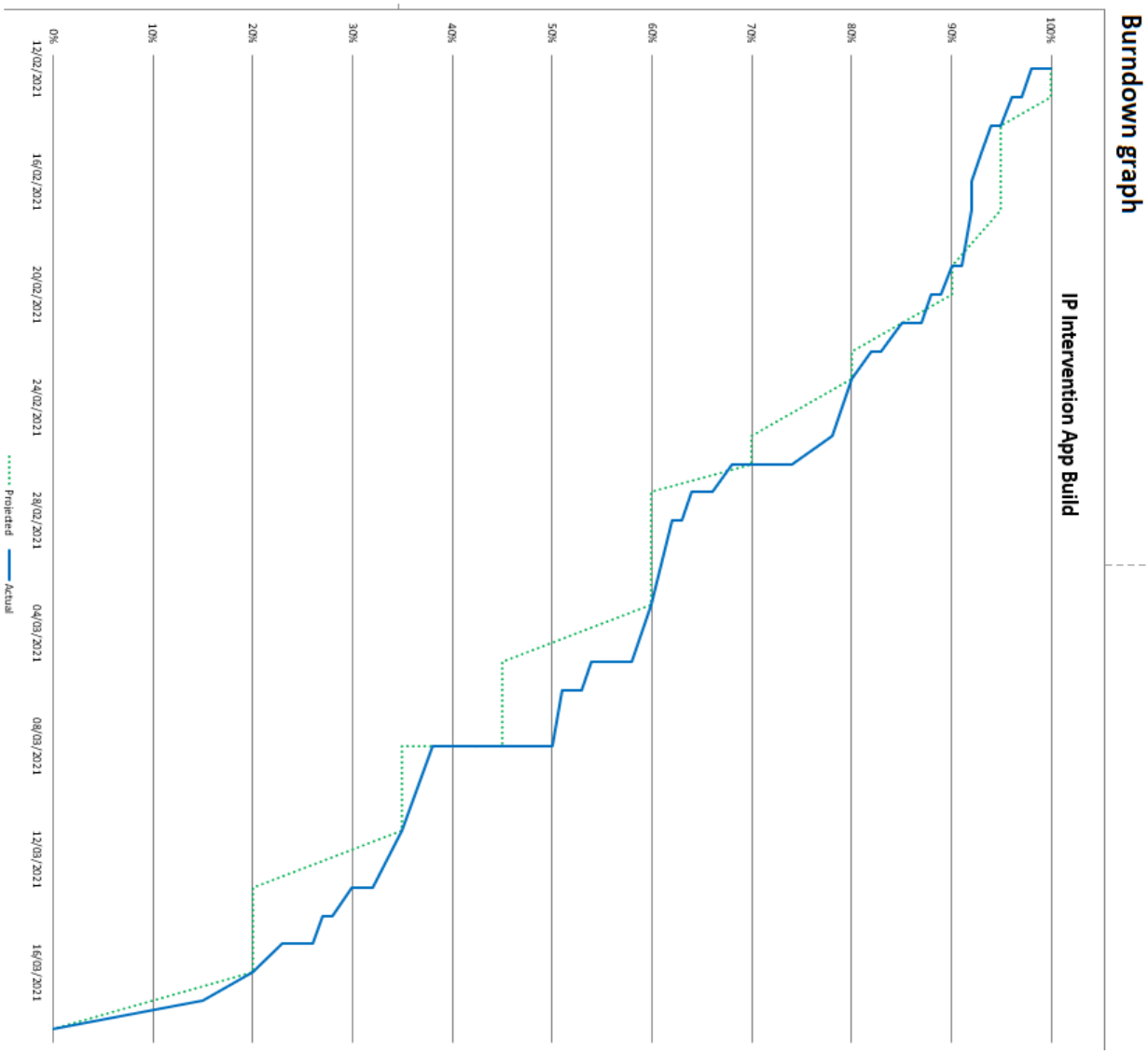
Task inventory

ID	Name	Weight [%]
1	General Layout	10%
1.1	Create View Structure	0%
1.2	Create Main Page Layout	0%
1.3	Create Tabs	0%
1.4	Test Basic Controller Setup	0%
2	Setup	5%
2.1		0%
2.2	Save Name	0%
2.3	Digitise Survey	0%
2.4	Calculate Results	0%
2.5	Save and Retrieve from DE	0%
2.6	Populate and Activate Per	0%
3	Personal Tab	5%
3.1	Create Tabs + UI	0%
3.3	Populate from DB	0%
4	Information Tab	5%
4.1	Create Tabs + UI	0%
4.2	Create Informational Temp	0%
4.3	Create Navigational Points	5%
5	Tailored Plan	5%
5.1	Order Targetted behaviour	0%
5.2	Present Results	0%
6	Achievements Tab	10%
6.1	Achievements Model	0%
6.2	Create Tabs + UI	0%
6.3	Achievements Template	0%
6.4	Add Achievements Activity	0%
7	Abilities Tab	10%
7.1	Abilities Model	0%
7.2	Create Tabs + UI	0%
7.3	Abilities Template	0%
7.4	Present Abilities	0%
8	Goals Tab	15%
8.1	Research Goal-Setting	0%
8.2	Create Tabs + UI	0%
8.3	Create Models	0%
8.4	View Goals	0%
8.5	View Tasks	0%
8.6	Add Goals	0%
8.7	Add Task	0%
8.8	Create Reflect Option	0%
9	Goal Reflection	10%
9.1	Reflection Functionality	0%
10	Content	15%
10.1	Information Tab Content	0%
10.2	Help Buttons Content	0%
10.3	Various Other Content	0%
10.4	Achievements Type Conte	0%
10.5	Abilities Type Content	0%
11	Misc + Graphics	10%
11.1	Various fixes	0%
11.2	Cips Tab	
11.3	Settings Tab	
11.4	Graphics	
11.5	Package APK	

Task completion log

Completed tasks			Projected	Actual	Task completion [%]
Task ID	Task ID	Date			
1	1	########	100%	100%	
1.1	1.1	########	100%	99%	
1.2	1.2	########	100%	98%	
1.3	1.3	########	100%	97%	
1.4	1.4	########	100%	96%	
2	2	########	95%	95%	
2.1	2.1	########	95%	95%	
2.2	2.2	########	95%	94%	
2.3	2.3	########	95%	93%	
2.4	2.4	########	95%	93%	
2.5	2.5	########	95%	92%	
2.6	2.6	########	95%	92%	
3	3	########	90%	91%	
3.1	3.1	########	90%	90%	
3.3	3.3	########	90%	89%	
4	4	########	90%	88%	
4.1	4.1	########	85%	87%	
4.2	4.2	########	85%	86%	
4.3	4.3	########	85%	85%	
5	5	########	80%	83%	
5.1	5.1	########	80%	82%	
5.2	5.2	########	80%	80%	
6	6	########	70%	80%	
6.1	6.1	########	70%	78%	
6.2	6.2	########	70%	74%	
6.3	6.3	########	70%	72%	
6.4	6.4	########	70%	70%	
7	7	########	60%	68%	
7.1	7.1	########	60%	66%	
7.2	7.2	########	60%	64%	
7.3	7.3	########	60%	62%	
7.4	7.4	########	60%	60%	
8	8	########	45%	58%	
8.1	8.1	########	45%	55%	
8.2	8.2	########	45%	54%	
8.3	8.3	########	45%	53%	
8.4	8.4	########	45%	51%	
8.5	8.5	########	45%	51%	
8.6	8.6	########	45%	50%	
8.7	8.7	########	45%	48%	
8.8	8.8	########	45%	45%	
9	9	########	35%	38%	
9.1	9.1	11/03/2021	35%	35%	
10	10	########	20%	32%	
10.1	10.1	########	20%	30%	
10.2	10.2	########	20%	28%	
10.3	10.3	########	20%	27%	
10.4	10.4	########	20%	26%	
10.5	10.5	########	20%	23%	
11	11	########	20%	20%	
11.1	11.1	########	10%	18%	
11.2	11.2	########	10%	12%	
11.3	11.3	########	10%	10%	
11.4	11.4	########	10%	5%	
11.5	11.5	########	0%	0%	
			0%	0%	

Burndown graph



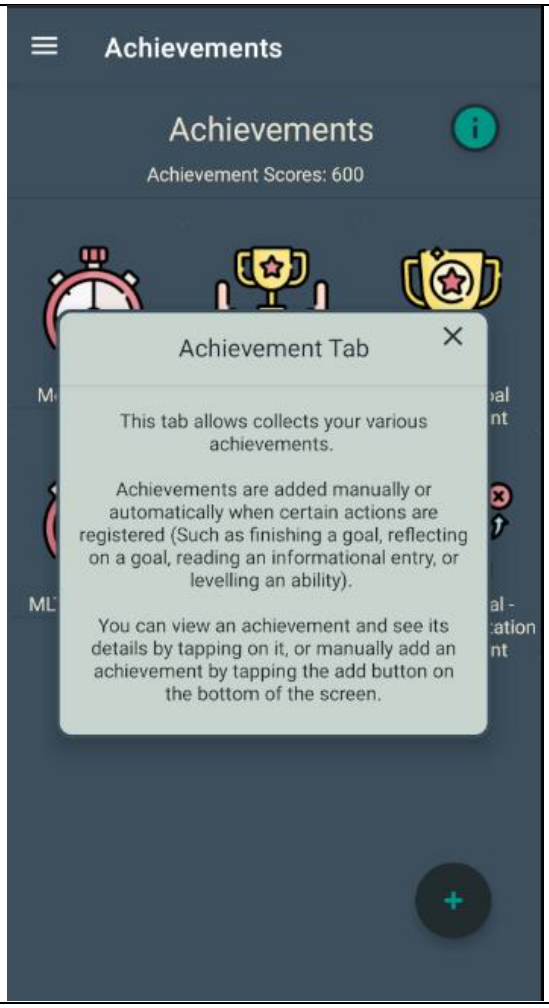
9) Appendix 9: User Stories Sprint Plan Split

Sprint	User Stories IDs (from Requirements List)
1 – Setup + Main	User stories 1, 2, 3, 4
2 – Personal + Information	User stories 5, 14
3 – Achievements + Abilities	User Stories 6, 7, 8, 9, 21
4 – Goals + Reflection	User Stories 10, 11, 12, 17, 18
5 – Content + Misc.	User Story 13, 15, 16, 19, 20, 22

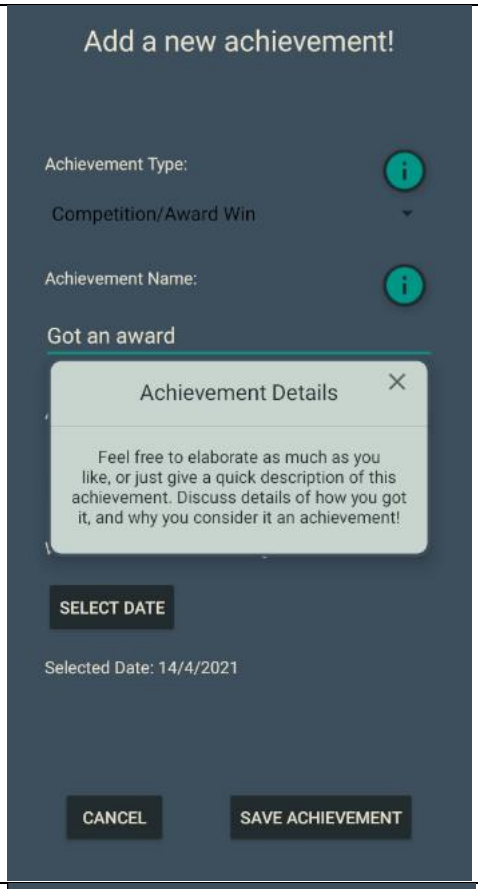
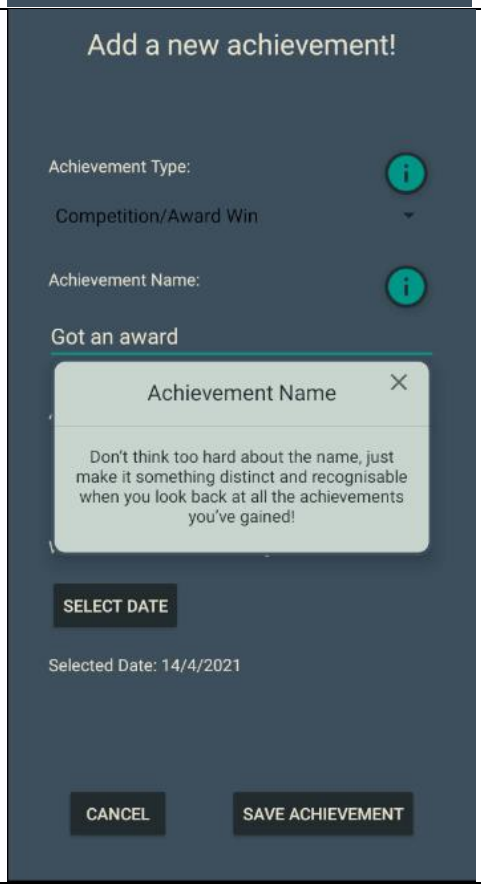
10) Appendix 10: Achievement Types and Scores:

Achievement	Score	Addable by User
Small Goal	100	-1
Medium Goal	200	-1
Large Goal	300	-1
Meeting Deadline	50	1
Overcoming Blocker	50	1
Large Task List	50	-1
Ability Boost	25	-1
Aligned Expectation	50	-1
Ability Level-Up	10	1
Personal Goal	200	1
Completed Assignment	100	1
Received Feedback	100	1
Reached Milestone	300	1
Self-Reflection	100	1
Competition/Award Win	200	1
Other	50	1

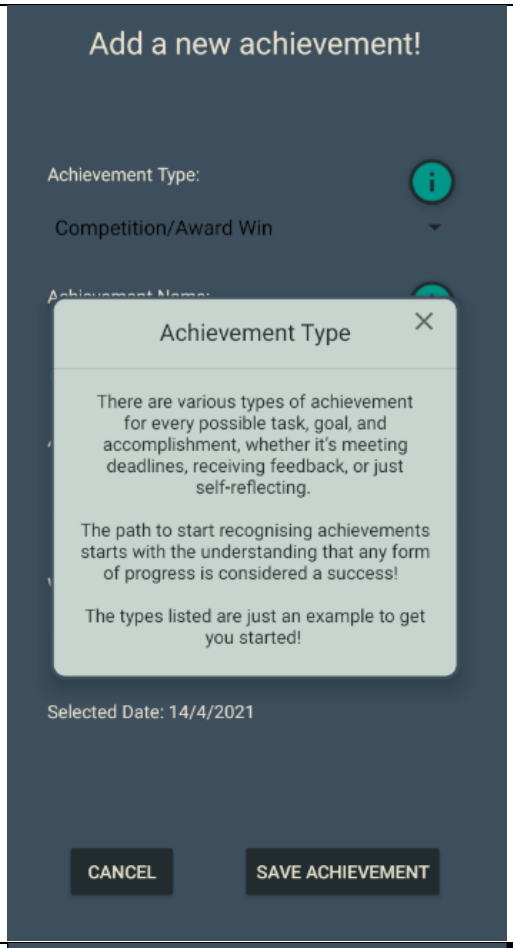
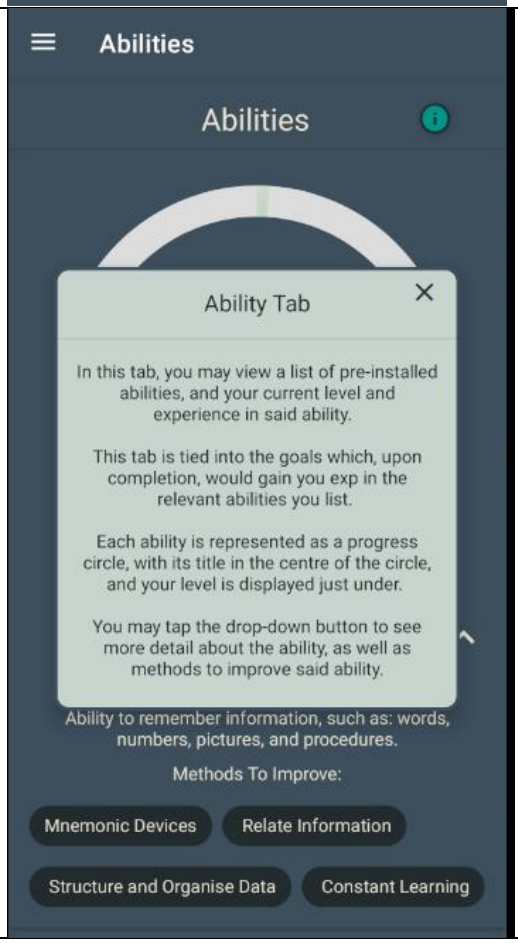
11) Appendix 11: Application Help Popups Screens

Achievements Tab – Tab Help	

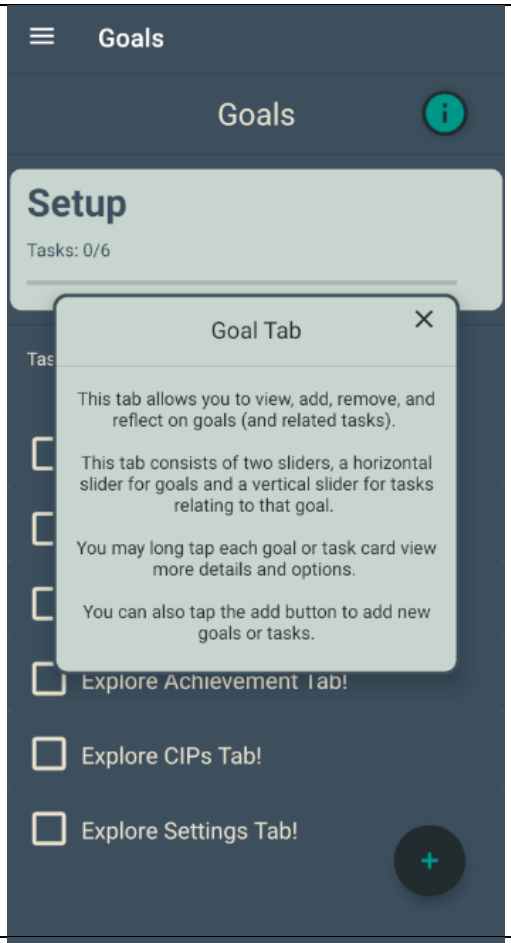
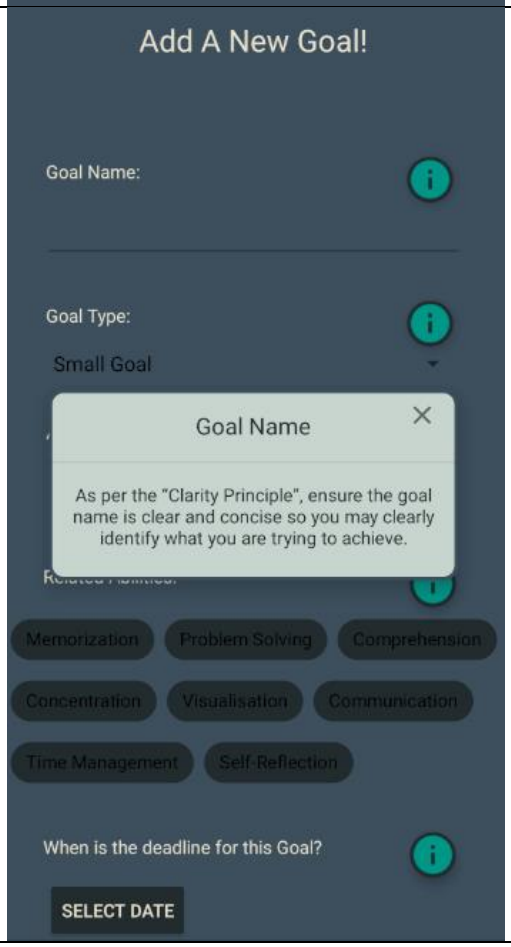
Appendix

Achievements Tab – Achievement Details Help	
Achievements Tab – Achievement Name Help	

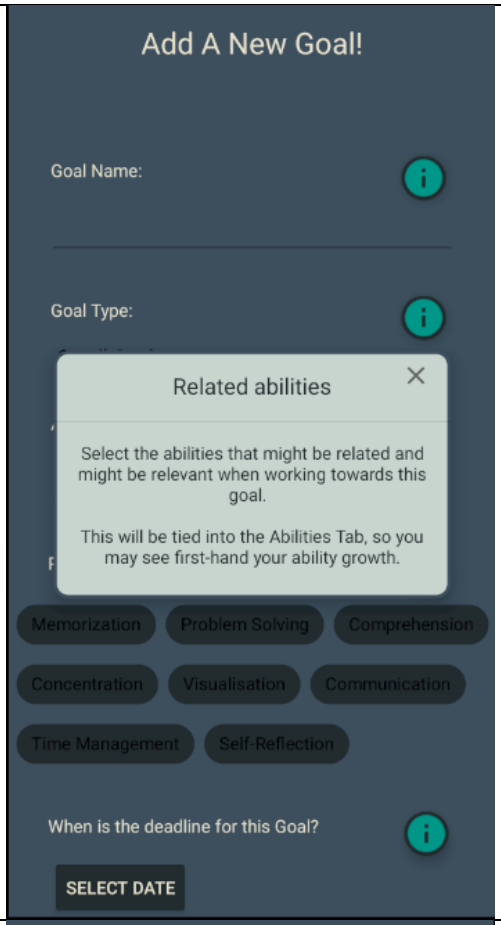
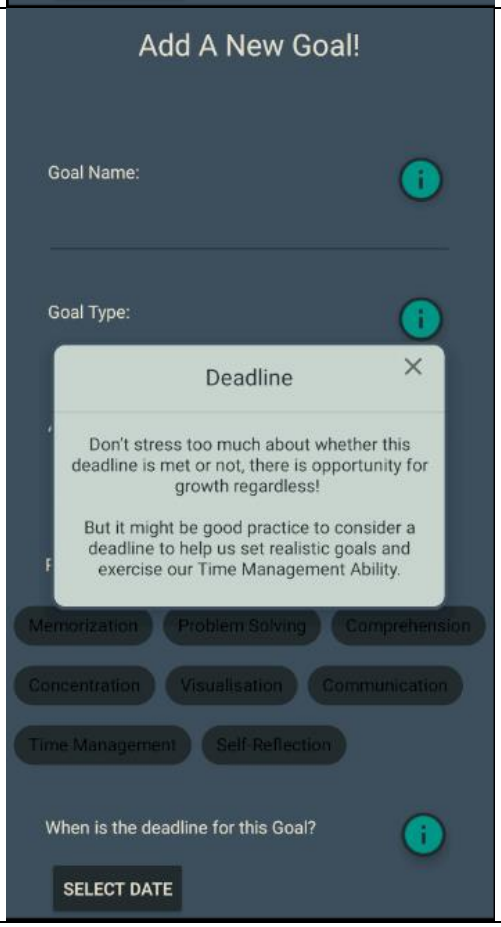
Appendix

Achievements Tab – Achievement Type Help	
Abilities Tab –Abilities Tab Help	

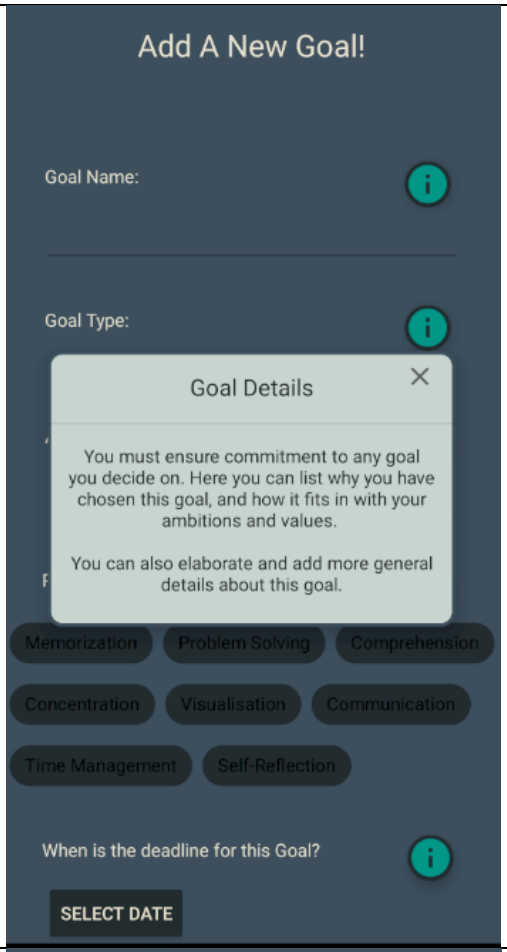
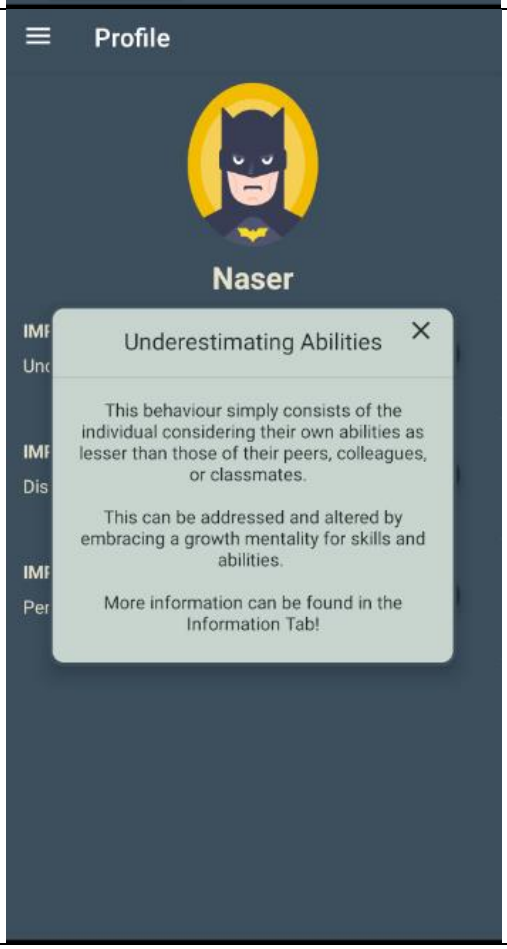
Appendix

Goals Tab – Goals Tab Help	
Goals Tab –Goals Name Help	

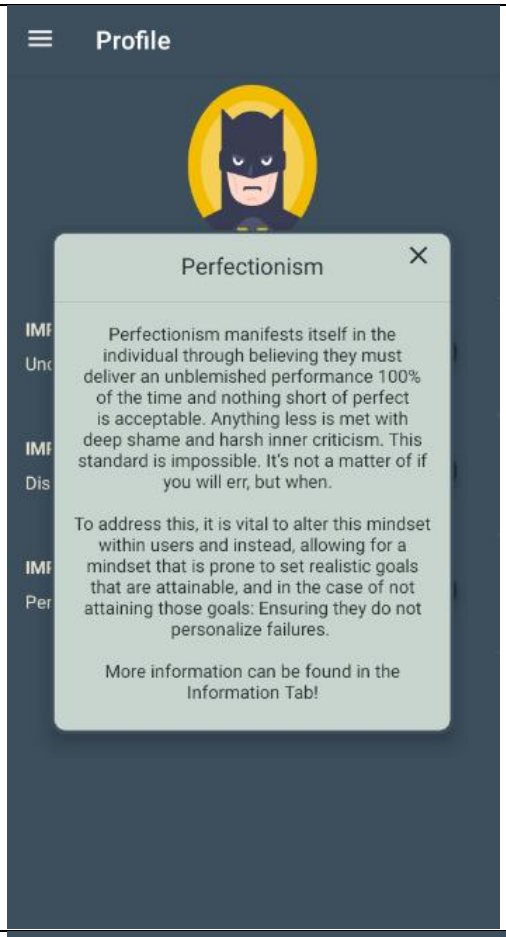
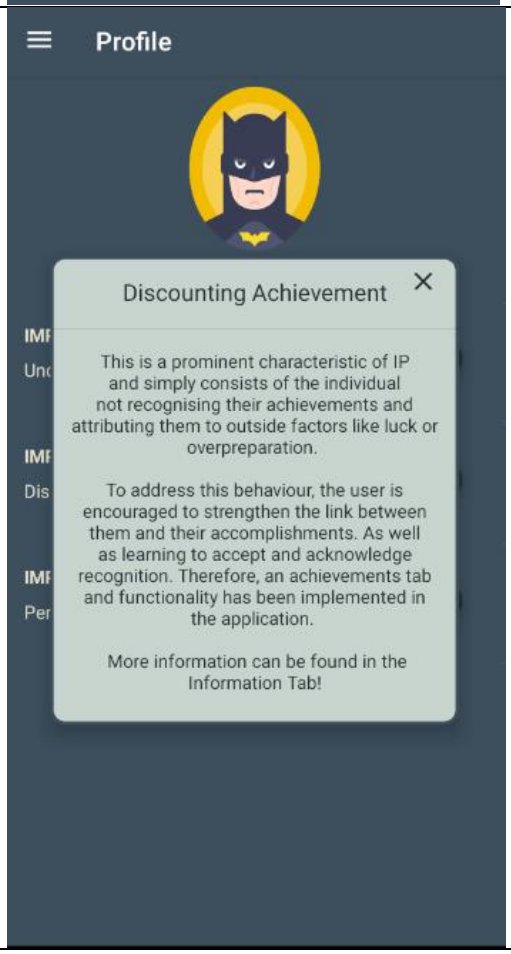
Appendix

Goals Tab – Related Abilities Help	
Goals Tab – Deadline Help	

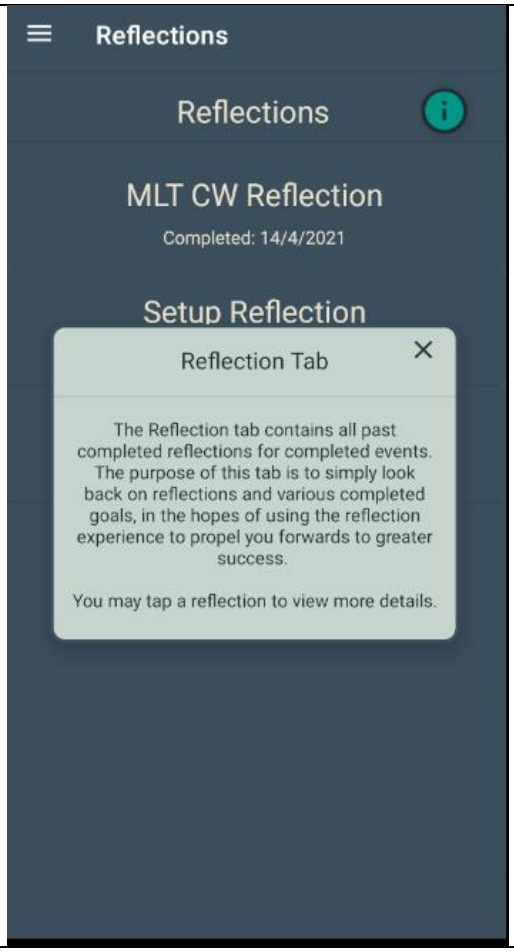
Appendix

Goals Tab – Goal Details Help	
Personal Tab – Underestimating Abilities Help	

Appendix

Personal Tab – Perfectionism Help	
Personal Tab – Discounting Achievements Help	

Appendix

Reflections Tab – Reflections Tab Help	

12) Appendix 12: Functionality Testing Full Results

No.	Requirement	Outcome
1	Setup must start on first usage.	Success
2	user can add a name during setup.	Success
3	user can add a picture during setup.	Success
4	Setup introduces users to CIPs.	Success
5	Users can conduct CIPs at setup.	Success
6	System calculates User's CIPs Score.	Success
7	System identifies target behaviours.	Success
8	System creates a personal plan by prioritising behaviours.	Success
9	System stores Setup data.	Success
10	System loads user and setup data at application start.	Success
11	application should have a navigation drawer to traverse through tabs/sections.	Success
12	main page should display active tab/section.	Success
13	Information tab contains information entries.	Success
14	User can scroll across information entries.	Success
15	User can select Information entry.	Success
16	User should be able to read through activity.	Success
17	Achievements tab records achievements.	Success
18	User can select achievement to view.	Success
19	User can start "add achievement" activity by selecting the add achievement button.	Success
20	User can add achievement name.	Success
21	User can add achievement type.	Success
22	User can add achievement details.	Success
23	User can add achievement date.	Success
24	User can view abilities in abilities tab.	Success
25	User can select drop down option to view further details.	Success
26	System automatically adds exp to related abilities when goal is complete.	Success
27	User can view goals in goals tab.	Success
28	Users can view tasks related to each goal.	Success
29	User can switch across different goals.	Success
30	User can long tap a goal to see further detail.	Success
31	User can delete goal.	Success
32	User can add a goal.	Success
33	User can add goal name.	Success
34	User can add goal type.	Success
35	User can add goal details.	Success
36	User can add goal deadline.	Success
37	User can select related abilities.	Success
38	User can edit task name.	Success
39	User can delete task.	Success
40	User can check off completed task.	Success
41	application records completed tasks.	Success
42	User can reflect completed goal.	Success

43	User can reflect on greatest achievement.	Success
44	User can reflect on best ability.	Success
45	User can reflect on blocker.	Success
46	User can reflect on deadline.	Success
47	User can reflect on success.	Success
48	User can reflect on expectation.	Success
49	System Removes reflected goals.	Success
50	Reflected goals are added to reflections tab.	Success
51	Each tab should contain a help button.	Success
52	User can select button and receive a Pop-up.	Success
53	User should be able to view their personal details.	Success
54	User should see personal plan in personal tab.	Success
55	User should be able to view more detail about their plan when selecting each behaviour.	Success
56	User should be able to see their progress when reading.	Success
57	System should keep track of user reading progress.	Success
58	Information should be unlocked sequentially.	Success
59	System should add automatic achievements when finishing goals.	Success
60	System should detect completion and deadline.	Success
61	System should give achievement if deadline met.	Success
62	Reflections tab contains past reflections.	Success
63	Past reflection should contain goal information.	Success
64	Past reflection should contain all completed tasks.	Success
65	Past reflection should contain user reflection information.	Success
66	CIPs sections contains past CIPs.	Success
67	User can take more CIPs surveys.	Success
68	User can drop down CIPs Breakdown.	Success
69	Achievements tab displays scores.	Success
70	Achievements tab calculates sum achievement scores.	Success
71	User can select the reset button to delete all information and reset the application.	Success
72	application prioritises tabs.	Failure
73	application unlocks tabs sequentially.	Failure
74	User can set notifications.	Failure
75	System notifies the user based on selection.	Failure
76	User can add another user as supervisor.	Failure
77	User can set access to supervisor.	Failure
78	Supervisor has access to allowed information and tabs.	Failure
79	Supervisor can comment on user’s actions.	Failure
80	User can set a username and password.	Failure
81	User can login at application start.	Failure
82	System can authenticate users.	Failure
83	System can populate information from an online server,	Failure
84	CIPs tab includes graphs of users CIPs Results.	Failure
85	Users can modify granularity of CIPs Graph.	Failure
86	Users can switch between graph of different abilities.	Failure

13) Appendix 13: Usability Study Part 1 Tasks

No.	Task
1	Setup and Initial CIPs
2	Information Tab: Read an Entry
3	Ability Tab: Explore an ability
4	Achievements Tab: Add a new Achievement
5	Goals Tab: Complete pre-installed goal, reflect on goal.
6	Reflections Tab: View completed reflection
7	CIPs Tab: View previous CIPs
8	Settings tab: Delete user info (Kill Switch)

14) Appendix 14: Usability Study Part 2 Tasks

No.	Task
1	Pre-study Survey (link: https://www.isurvey.soton.ac.uk/39529)
2	Setup and Initial CIPs
3	Short Term Goal: complete the pre-installed Setup goal and have a quick reflection
4	Medium Term Goal: Add your own personal goal to be completed within a day with (1-3) tasks and reflect
5	Long Term Goal: Assign a week-long goal with (3+) tasks and reflect
6	Long Term Goal: Complete ALL the information entries (across several days)
7	Post-Study Survey (link: https://www.isurvey.soton.ac.uk/39533)

15) Appendix 15: Usability Study Post-Survey Questionnaire (Note: Pre-study Questionnaire consists solely of the IP Familiarity Section, but is otherwise similar)

Imposter Phenomenon Post-Study Survey

Hello and thank you for taking part in this study!

This survey will be taken at the end of the study, and has two sections:

1) A familiarity study similar to the one taken in the pre-study survey. This is to measure your familiarity with the Imposter Phenomenon compared to your familiarity before the study.

2) A quick usability survey to determine the application's usability and record any feedback and opinions you may wish to add.

Section 1. Clance IP Scores

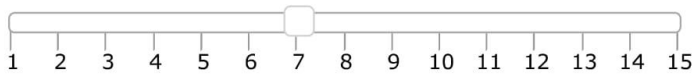
This section will simply ask for your Clance score pre and post study!

Question 1.1

What was your Clance Score from Setup (The first Clance entry under CIPs)?

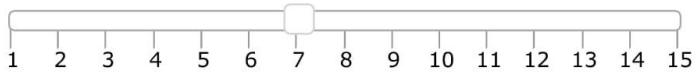
Question 1.2

What was your "Underestimating Abilities" Score from Setup (under the breakdown for the first Clance entry under CIPs)?



Question 1.3

What was your "Discounting Achievements" Score from Setup (under the breakdown for the first Clance entry under CIPs)?

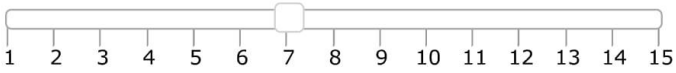


16)

Appendix

Question 1.4

What was your "Perfectionism" Score from Setup (under the breakdown for the first Clance entry under CIPs)?

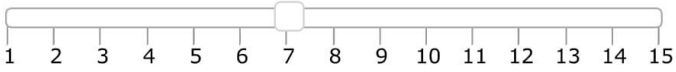


Question 1.5

What was your Clance Score after the study (The LAST Clance entry under CIPs)?

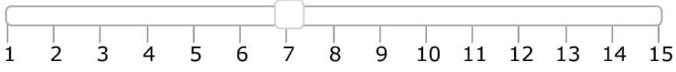
Question 1.6

What was your "Underestimating Abilities" Score after the usability study (under the breakdown for the Last Clance entry under CIPs)?



Question 1.7

What was your "Discounting Achievements" Score after the usability study (under the breakdown for the Last Clance entry under CIPs)?



Appendix

Question 1.8

What was your "Perfectionism" Score after the usability study (under the breakdown for the Last Clance entry under CIPs)?

Section 2. Imposter Phenomenon Familiarity

Question 2.1

How familiar are you with the Imposter Phenomenon (Hereafter IP)?

- ○ Very familiar, and have deep understanding of it.
- ○ Know the phenomenon and have some understanding of it.
- ○ Recognise the term but do not know any details.
- ○ Never heard about it.

Question 2.2

Which of these would you say are **cases** of IP?

	Is a case of IP	Might be a case of IP	Is not a case of IP	Not sure
Liam is anxious to discuss university course assignments with his colleagues, as he is afraid of being revealed as a fraud.	○	○	○	○
Mustafa procrastinated work over his coursework until the last minute to play videogames, and is upset when he gets an acceptable but not a high grade.	○	○	○	○
Sam is afraid of failing his final exam as he hasn't studied throughout the semester.	○	○	○	○
Marie finished her task successfully a few days before the deadline but is upset when a minor issue is discovered, leading her to count the task as a failure.	○	○	○	○
Benjamin has a challenging task due soon, as the	○	○	○	○

deadline approaches, he is more and more afraid of failing, and works extra hard to ensure he succeeds.				
James completed a tough task recently, but when his colleagues congratulate him, he dismisses the task as being "too easy and nothing important".	○	○	○	○
Rajish is quite good at his job, he believes this is due to several extra courses and degrees he has attained through the years.	○	○	○	○
Sue does not tell her family much details about her successful job, as she is afraid they will think she is showing off her success.	○	○	○	○
Salim does not like to mention his recent graduation from a challenging university, as he is certain he graduated due to luck.	○	○	○	○
Mathilde is anxious over an upcoming deadline for a project similar to various projects she has completed in the past.	○	○	○	○
Camille is working on a project, but her goals constantly increase and it seems her workload just keeps growing.	○	○	○	○

Question 2.3

How many people would you say suffer from IP?

- ○ More than 80%
- ○ 61% - 80%
- ○ 41% - 60%
- ○ 21% - 40%
- ○ 20% or Less

Question 2.4

1. How familiar are you with the **causes** of IP?

- ○ Very familiar, and have deep understanding of them.
- ○ Know the causes and have some understanding of them.
- ○ Recognise the causes but do not know any details.
- ○ Never heard of them.

Question 2.5

Which of these would you say are **causes** of IP?

	Is a cause of IP	Might be a cause of IP	Is not a cause of IP	Not sure
Ambitious personality	○	○	○	○
Challenging lifestyle	○	○	○	○

Appendix

Perfectionism	○	○	○	○
Social Anxiety	○	○	○	○
Learning difficulties	○	○	○	○
Family expectations	○	○	○	○
Constant Criticism from family and teachers.	○	○	○	○

Question 2.6

1. How familiar are you with the **effects** of IP?

- ○ Very familiar, and have deep understanding of them.
- ○ Know the effects and have some understanding of them.
- ○ Recognise the effects but do not know any details.
- ○ Never heard about them.

Question 2.7

Which of these would you say are **effects** of IP?

	Is an effect of IP	Might be an effect of IP	Is not an effect of IP	Not sure
Stress and/or Anxiety	○	○	○	○
Depression	○	○	○	○
Social incompetence	○	○	○	○
Over-achieving mentality (ever growing goals and aspirations)	○	○	○	○
Rejecting assistance	○	○	○	○
Lack of confidence and self-esteem	○	○	○	○
Lack of attention	○	○	○	○
Procrastination	○	○	○	○

Question 2.8

How serious do you consider the **effects** of IP are?

- ○ Very serious
- ○ Somewhat serious
- ○ Not very serious
- ○ Not serious at all

Question 2.9

1. How familiar are you with the **behaviours** of IP?

- ○ Very familiar, and have deep understanding of them.
- ○ Know the behaviours and have some understanding of them.
- ○ Recognise the behaviours but do not know any details.

Appendix

○ Never heard about them.

Question 2.10

Which of these do you think are **characteristics** of the IP (ways IP manifests)?

	Is a characteristic of IP	Might be a characteristic of IP	Is not a characteristic of IP	Not sure
Guilt about success	○	○	○	○
Restlessness when deadlines approach	○	○	○	○
Stress over excessive workload	○	○	○	○
Underestimating abilities	○	○	○	○
Lack of attention	○	○	○	○
Perfectionism	○	○	○	○
Discounting achievements	○	○	○	○
The need to be the best	○	○	○	○
Avoiding criticism	○	○	○	○
Fear of failing upcoming goals and/or tasks	○	○	○	○
Superhero mentality (Working as hard as possible whenever possible)	○	○	○	○
Avoiding setting goals	○	○	○	○

Question 2.11

What **behaviour(s)** would you say this scenario entails?

	Discounting Achievements	Perfectionism	Underestimating Abilities	Not sure
Raul just wrapped up a difficult business deal, but when his boss praises him, he attributes the success to luck.	☐	☐	☐	☐
Malcolm is at his first university lecture, and realises that the other students are all exceptional, and there is just no way for him to match their level.	☐	☐	☐	☐
Mohammed submitted his coursework on time, but is disheartened that he was not able to complete the extra tasks.	☐	☐	☐	☐
Lucas and his colleagues were awarded a coupon to an escape room. However, Lucas is anxious of attending, as he is worried he might let the team down.	☐	☐	☐	☐
Chris constantly stays at work longer than his assigned work hours, as he feels he works slower than his colleagues and he needs to ensure he meets all his tasks by the same deadlines.	☐	☐	☐	☐

Appendix

Section 3. Usability Survey

Question 3.1

System ease of use:

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
People using it once or many times would like.	○	○	○	○	○
In a few steps it does what I want.	○	○	○	○	○
It lets me do several things.	○	○	○	○	○
It is easy to understand.	○	○	○	○	○
I don't notice any problems as I use it.	○	○	○	○	○
Mistakes can be fixed quickly and easily.	○	○	○	○	○
It is simple to use.	○	○	○	○	○
It is easy to use.	○	○	○	○	○
Using it requires no effort.	○	○	○	○	○
I can use it well every time.	○	○	○	○	○
I can use it without written instructions.	○	○	○	○	○

Question 3.2

Quality of Support Information:

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
The instructions and messages are easy to understand.	○	○	○	○	○
The messages to fix problems are clear.	○	○	○	○	○
The instructions and messages are clear.	○	○	○	○	○

Question 3.3

System Ease of Learning

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I quickly became good at it.	○	○	○	○	○
I easily remember how to use it.	○	○	○	○	○
It is easy to learn to use it.	○	○	○	○	○
I learned to use it quickly.	○	○	○	○	○

Question 3.4

System Satisfaction

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I am happy with this app.	○	○	○	○	○
	○	○	○	○	○

I would tell a friend about this app.					
This app is fun to use.	○	○	○	○	○
This app works the way I would want it to work.	○	○	○	○	○

Thank you for taking this questionnaire!