School of Computing

Personal Learning Analytics Application for Students

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Abstract

There are academic and non-academic factors that might influence university students' achievement. The academic factors may be seen as important academic skills which directly influence students' achievement. However, non-academic qualifications, such as time management, are equally important and need investigation. Many students struggle to balance and manage their academic work with their busy social life, which leads to increased academic stress and time management issues. Students' lack of time management skills is a common problem. Since university students have great influence over their academic responsibilities, they are frequently required to work independently. While participating in the learning process on campus, students must plan, monitor, and control their own studies. Therefore, students must learn how to effectively manage their time in order to submit assignments on time and enhance their academic success.

In this research, we examined how students felt about using sensors or a tracker system to record their regular activities. It is crucial to understand how students feel about utilizing this data since sometimes the information acquired from sensors or a tracker system is completely personal information. In this research, we gather students' perceptions of several data sources that may aid in their Time Management self-reflection. We propose various data sources, ranging from students' activities data on campus, online activity, and physical activity data the analyze the usefulness and sensitivity of each data source based on students' opinions. We also investigate students' willingness to expose their data to others, whether to provide it as identifiable information, anonymously or not share at all. This study also explores a gamification approach that might increase users' engagement.

Adopting a User-Centred Design (UCD) approach in this study, students completed a questionnaire about the data sources useful for their self-reflection during the learning process. It showed that students preferred the data sources that helped them improve time management by recording their daily activities. The use of location data helped students record their activities retrospectively and figure out what activities they had done. Students also participated in group discussions to define the design considerations. Then, they are also involved in usability and acceptance tests to evaluate the mobile app.

This study showcases how a UCD approach could be applied to designing and evaluating students' preferences for their time management app. It contributes to the knowledge of user-centred design in several ways. Firstly, this study provides an understanding of how students perceive their data, which is helpful for their self-reflection in time management and their privacy preference regarding disclosing the information to others. Secondly, this study contributes design considerations as a set of design guidelines and recommendations that practitioners should take into account when developing time management apps for students.

Publication

The research presented in this thesis has been published in the following peer-reviewed conference:

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Table of Contents

List of Figures

List of Table

Chapter 1. Introduction

There are academic and non-academic factors that may influence higher education students' performance. The academic related factors may be perceived as relevant academic skills, such as developing critical thinking in an educational context through access to academic resources, teaching and assessment (Adams and Blair, 2019). The non-academic factors are also important and deserve investigation, for example time management skills. Many students find it is hard to balance and regulate both their studies and busy external lives, which lead to increasing levels of academic stress and time mismanagement (Reddy, et al, 2018). Poor time management skills for students is a universal problem (Fidalgo et al, 2020). Many students struggle managing their time to complete their tasks. At University, students often are required to work independently since they have considerable autonomy for their studies. Students are required to plan, monitor and control their own study while engaging with the learning process on campus. Therefore, students need to learn how to effectively manage their workload to ensure they submit assignments on time.

Many students face time management obstacles because their tasks are abstract and require large periods of unstructured time (Lund and Wiese, 2021). To overcome this situation, students need to organise, plan and decompose tasks into smaller chunks of time so task progress can be measured and evaluated regularly. There are several time-management apps to help students to improve their management skill by check things off their to-do list, and generally be more organised, stay focused and efficient. Some apps work to improve users' productivity by task organising, such as Trello[1]. Students may use this app to collaborate with other students, organise plan and tasks, and document ideas and notes in the form of boards, cards and lists. Evernote[2] is popular tool for note-taking and task planning. This app supports users by supporting sharing project files with others, documentin ideas in the form of notes and storing notes, images and web clips.

[1] https://www.trello.com/
[2] https://evernote.com

Some students may used tools that help them to block social media or other distracting activities, such as Forest[3]. This tool help its users beat their phone addiction and uses the pomodoro technique (Feng et al, 2019) to manage their time. When focusing on doing something important the users do not use their phones for a period of time, and they get credit and can plant real trees with their credits. SelfControl[4] is a well known app for its simple user interface to help Macbook users block their access to distracting websites, such as YouTube, Netflix or other internet sites. Students may use this app for a period of time when they are studying, writing and want to stay focused while finishing an assignment. These kinds of time management apps are already used widely amongst workers to track their habits and behaviours.

Time management skill is important for students to have success throughout their study. Recent research explore time management apps used to support the students. Hashim et al (2020) supported students time management by reporting and visualising the time needed by students according the schedule and credits of their courses. The MyMobileSLT application was developed as the supplement of MySLT (Student Learning Time) book which calculates the amount of time that the students need to allocate for study for each course each semester. Khiat (2021) explored the time management features in a student Learning Management System (LMS). They reported that the students who enabled the time management features were able to finish the course in a shorter time.

However, those Time Management applications were designed and developed from the designer's perspective. This research still did not consider the students' perception of which data sources provide valuable feedback. Since students will be the significant actors who will use the app, getting their opinion is crucial when designing Learning Analytics (LA) applications. According to Cruz-Benito et al. (2015), regardless of the app's type, user perception and engagement are vital aspects of a successful technological system. Therefore, in this research, we involve students to build Time Management a application to support their self-reflection process.

[3] https://www.forestapp.cc
[4] https://selfcontrolapp.com

Yan (2018) stated that user perceptions might directly or indirectly impact user acceptance of a technology and its effectiveness. Therefore, managers, designers, system developers, or administrators may use information about user perceptions to adapt, enhance or modify the technology to improve user acceptance. Furthermore, Estriegana et al. (2019) stated that user acceptance is one of the critical factors determining the success or failure of software implementation.

To involve students in designing their time management application, we should consider the concept of user-centred design as an evidence-based approach that engages with and prioritises the needs of end-users (Farao et al., 2020). Using a user-centred design approach, an initial user interface was developed, tested, and refined to create a final user interface (Perebner et al., 2019). Some benefits of using user-centred design are evaluating various alternatives that can be performed at an early stage of development and refining more precise requirements based on user input (Farao et al., 2020; Ortiz-Crespo et al., 2021).

Liyanage et al. (2021) conducted the combination of design-thinking and user-centred design for a student Time Management Assistants. They interviewed students for brainstorming ideas and used a questionnaire to get low fidelity feedback. The application features that they use in their study include: homescreen, notifications, user profile, today's schedule, upcoming and completed deadlines, modules, calendar, progress, and settings. The high fidelity results were discussed with 8 undergraduate students to get their feedback and rating. Their study proposed many features that asked the students to fill in all of the information into the application. This situation may lead to more stress when students use the application and have to put all their daily activities schedule information (Lund and Wiese, 2021).

Trujillo (2021) also used user-centred design to develop Time Management applications specifically designed for Informatics students. He conducted two design workshops and asked the students to draw mock-ups for the applications. The mock-ups then were implemented in Figma and discussed in group sessions using Stakeholders Walkthrough protocols (Kauffman et al., 2020). Lastly, the students were asked individually about the path they used to complete the tasks and answered the SUS (System Usability Scale) questionnaire (Lewis, 2018). The app features proposed by this study were: daily task screen, event and calendar, timer, and stopwatch while completing a task.

Previous research by Liyanage et al (2021) and Trujilo (2021) shows the use of user-centred design in developing Time Management application for university students. Both studies rely on the students' commitment to entering all details of their daily activities into the application. The evaluation of these studies was also done at the level of design discussion with the students by conducting interviews to get students feedback and rating.

In our study, we investigated the students attitude to the use of sensors or a tracker system to help students record their daily activities. Because the information obtained from sensors or a tracker system is sometimes strictly personal information, therefore, it is important to know students' perceptions of using these data. In this study, we collect students' opinions of various data sources that may help them to have self-reflection about their Time Management. We investigate each data source's usefulness and sensitivity level according to their perceptions. We also explore students' willingness to disclose their data to others, whether to share it as identifiable information, anonymously or not share at all. This study also considers a gamification concept that might improve users' motivation to use the app.

This study explores various data sources, ranging from data on students' activities on campus, their online activities, and their physical activities that could be beneficial for students. Even though there have been attempts to investigate the use of User-Centred design to build the Time Management apps for students, there has been little discussion about students' perception regarding data privacy, specifically for those data that are obtained from sensors or tracking systems. We aim to fill in this gap by incorporating students' voices to understand their needs and preferences for creating highly usable apps.

We implemented a prototype interface based on our findings which was tested by students to gather their opinions and feedbacks. Their suggestions were then used to refine the initial interface and produce a revised one. The revised interface was then implemented and tested by students to get user experience in a natural environment.

1.1 Research Problem

Many students and knowledge workers acknowledged the benefits of engaging in more Time Management planning, such as feeling more committed to tasks, recognizing and

resolving conflicts in advance, and recognizing opportunities to use their time more effectively (Parke et al., 2018; Paruthi et al., 2018). However, Lund and Wise (2021) found that very few students consistently and fully engaged in time management planning during their studies.. The students either only partially engaged, left out information, or did not engage in planning at all on certain days. This behavior may be caused by the large number of fields in the application that were needed to be filled by the user.

We may be able to capture our daily activities in social connections and conversations using data from sensor-based modeling, such as wearable computing devices (Ali et al., 2021). We also may use physical activity data through accelerometers, pedometers, heart rate monitors, and location trackers (Conger et al., 2022) to help us recorded our activities in a daily timeline. These sensor-based data are automatically collected but are often incomplete, particularly with regard to a student's activity context. Siemens (2013) suggest including additional data through observation and human input to enrich data which may support holistic analysis. As a starting point, this research will investigate the use of various data sources, combining automated tracking and self-declared data in Time Management application for students.

However, some privacy and trust issues may arise regarding the idea of using location tracking automation in Time Management apps. Regarding disclosing information to others, some students might feel reluctant, while others may not. This study aims to investigate how students perceive various data sources that could be useful for their self-reflection and their willingness to disclose their information to others, e.g. their personal tutor, the university or their peers. To accomplish the research aim, we want to answer the following research questions.

RQ1: *What are students' views regarding data privacy and how do they want to disclose the data from different sources outside a VLE in their time management apps?*
There are many data sources derived from activities outside a VLE that may support students' time management. Our study explores various data sources, ranging from data on students' activities on campus and online and their physical activities. Students may think some data sources are sensitive, so they might be reluctant to share them with others. This research question aims to understand students' views regarding how sensitive the information for student and their willingness to share the information with others. We use

an online questionnaire to collect data from students. To analyze the result, we apply visualization techniques to help us understand the relationships within the data.

RQ2: *What are the data sources expected by student to be useful for their Time Management app?*

The second research question aims to investigate students' opinion of the usefulness level of each data source. We investigate the data sources that are considered to provide valuable insights to help students' self-reflection regarding their time management. We use an online questionnaire to collect students' opinions. We hope that by knowing their views, students will be more willing to accept and use the time management app during their daily activities. Data sources are ranked based on questionnaire responses, and the selected data sources investigated further.

RQ3: *What are students' preference regarding the UI design, navigation and the content of students' time management app?*

The needs of users must be at the centre of the design process of an application. To capture the students preferences, we conduct group discussions to collect their opinions regarding the app design. To help students get immersed into our problem space, we use screenshots of similar application displays. By doing group discussions, we can investigate students creative thinking and ideas and perhaps find some different views. Audio recordings during the session are transcribed. Suggestions from students are collected and implemented into high fidelity design. The design then is validated to several students through several interviews in usability testing.

1.2 Contribution

Our research looks at a variety of data sources, including data on students' campus activities, online activities, and physical activities. Despite efforts to investigate the use of data derived from sources other than the VLE, there has been little discussion about students' perceptions of how useful the information is in supporting students' self-reflection through time management apps. There is also lack of discussion of how student perceive privacy and how they want to disclose the information in time management apps with others, such as personal tutor, university or peers.

1.2.1 Theoretical contribution

This research improved our understanding of students' privacy preferences when using data sources other than their VLE for time management apps. Previous research has shown that data collected by students from device sensors and tracker systems is sometimes strictly personal. As a result, understanding students' perceptions of using these data in time management apps and how they wish to share the information with others is critical. In this study, we collect students' perspectives on various data sources based on their activities and investigate how sensitive the information is in their eyes. We also look into students' willingness to share data with others, whether as identifiable information, anonymously, or not at all, with their tutor, university, or peers.

Furthermore, this study broadens understanding of students' expectations regarding data sources, which may aid in time management self-reflection. Some researchers are working on developing time management apps for university students and this research topic is becoming increasingly popular. Little is known, however, about students' perceptions of which data sources from device sensor and tracker systems may provide useful feedback for time management. Because students will be the primary users of the app, gathering feedback from them is critical. As a result, in this study, we involved students at design stage when developing personal time management apps to aid students' self-reflection.

Undergraduate students, according to our findings, would not share their data with their peers. Nonetheless, they are more likely to share identifiable data with tutors and anonymous data with the university, especially if the data reveals the students' productivity. Master's and PhD students are more careful and thoughtful when it comes to sharing information with others. They would prefer to share their data anonymously rather than reveal their identities. With the exception of data items in self-declared and tracker apps, Masters students are generally content to share their data anonymously with tutors, universities, and peers. PhD students are more likely to be extra careful when sharing their data with others. If the PhD students assume that the data contains sensitive information, they might decide not to share it with their tutors, university, or peers. When the information is less sensitive but still useful for self-reflection, PhD students will frequently share it with their tutor and the university anonymously.

Information in the categories of Library access and loan and Class attendance is generally regarded as less sensitive by all student groups. As a result, nearly all of them are willing to share this knowledge with others. Surprisingly, despite believing it to be less sensitive, undergraduate students do not want to share this information with their peers.

1.2.2 Practical contribution

This study produced practical contributions in addition to theoretical contributions. To begin, the design considerations proposed in this study can be used as a set of design guidelines because they provide recommendations that practitioners should take into account when developing time management apps for students. In order to create usable time management applications for university students, developers, including designers and managers, should be critically aligned with these considerations.

There are four topics in the design considerations that are investigated in this study.

1. Students attitude towards the location tracking mode that is used to record their location in time management apps.
2. Students' attitudes toward the possibility of revealing data to others (personal tutor, university, and peers).
3. Students' responses to gamification scenarios in order to increase their motivation to use the app.
4. Students' expectations of additional features that may supplement time management apps.

Second, this study also contributes to design considerations for layout, UI and navigation for developing students' time management app. Despite the general guidelines that are available to design websites (Ejaz et al., 2020; O'Hara and Fleger, 2020; Morley et al., 2020) or mobile apps (Wilson and Crabb, 2018; Baldwin and Ching, 2020; Lupanda and Rensburg, 2021), the design guidelines developed in this study, to the best of the my knowledge, fill a gap in design guidelines that specifically address mobile applications for supporting student time management.

1.3 Structure of Thesis

Chapter 1: Introduction

The current chapter introduces the aim and research problem, motivations behind the work carried out as part of this thesis and thesis structure.

Chapter 2: Research Background and Related Work

This chapters locates this thesis more firmly within the existing literature and reviews the previous theoretical and empirical work on which it is based. The literature review has been divided into several sub-chapters: time management apps, students view regarding their privacy, human-centred design approach, usability and user experience, mobile app development and mobile app distribution for testing

Chapter 3: Methodology

The third chapter focuses on the data collection, rationale and methods used for analysis in this thesis. This chapter discusses the justification for methodologies and the mixed-methods approach adopted in this research. The research methods and ethical considerations used in this thesis were also described in this chapter.

Chapter 4: Students' Perception on Various Data Sources for Self-Reflection on Time Management

This chapter addresses the first research question regarding students' view on data privacy and how they want to disclose the data from different sources outside VLE for their time management apps. This chapter also discusses the second research question about the data sources that is expected by student to be useful for their Time Management app. To answer those research questions, we examined students' questionnaire responses which assessing the usefulness and sensitivity of each data source, as well as students' willingness to share the information with others. To determine each cohort's preference, the analysis was built based on the level of students' degrees. This discovery was used to narrow down the data sources that we investigated further.

Chapter 5: Design Consideration for Students' Self-Reflection on Time Management app

This chapter addresses the third research question regarding student preference on the information that is recorded and presented in their time management apps. The selected

data source from the previous chapter was investigated in student group discussions. This chapter explores the students' thoughts on location tracking automation, disclosing students' information with others, the gamification concept for improving users' engagement and other factors that come up in student group discussions.

Chapter 6: Usability Testing of Application Prototype

This chapter further addresses the third research question regarding students' preference on the UI design and navigation for their time management apps. In this chapter, we attempt to discover design problems and insights from users' views using a prototype. The findings from Chapter 5 are used as source information to design a high-fidelity prototype. This prototype creation is an essential step in software product development to check the scenario design and user interface before fully developing the solution. Performing user tests with prototypes provides valuable feedback in the early design process to avoid costly mistakes. In this study, users reviewed the interface concurrently, using thinking aloud while completing the task scenarios. The students' voices in this study were used to find usability issues that are used as guidelines to improve the design of the apps.

Chapter 7: User Experience Evaluation on Mobile App

The last part of study includes user feedback after they have used the program to record their everyday activities. After completing a usability test and refining the design, more research is necessary to get user-experience (UX) feedback from students in their actual surroundings. After utilizing the application for a period of time, the students were invited to complete an online survey to gauge their level of satisfaction with the being tested mobile application.

Chapter 8: Conclusion

The final chapter summarises the conclusions of the work presented in Chapters 4 to 7. It considers how successful the research has been in fulfilling its aims and goes on to identify its original contributions and outline an agenda for future research. This chapter also describes the contribution, limitations and agenda for future research.

Chapter 2. Research Background and Related Work

Many knowledge workers and students acknowledge the advantages of increasing their time management planning for their academic success, including feeling more dedicated to tasks, addressing potential conflicts beforehand, and acknowledging the potential to use their time more efficiently (Parke et al., 2018; Paruthi et al., 2018). Lund and Wise (2021) discovered that only a small percentage of students consistently and completely engaged in full time management planning during their studies. On some days, students only partially engaged in planning activities, left out activities, or did not plan at all. This behaviour could be caused by there being too many fields in the application of Lund and Wise (2021) application that the user must fill out.

Using data from sensor-based modelings, such as wearable computing devices, we may be able to record our day-to-day activities in terms of social relationships and interactions with other people (Ali et al., 2021). Pedometers, accelerometers, heart rate sensors and GPS trackers may all provide us with physical activity data that we can use to record our daily activities on a timeline (Conger et al., 2022). These sensor-based data are acquired automatically, but they are usually insufficient for students' self-reflection, especially in terms of the context of students' activities. In order to make extra data more useful, comprehensive, and transferrable, Siemens (2013) suggests to combine data from sensors and users' manual input. This would make the data more comprehensive. The present study investigates the usage of multiple data sources that might be potential to help students self-reflection in terms of time management.

We may be able to capture our daily activities in social connections and conversations using data from sensor-based modeling, such as wearable computing devices (Ali et al., 2021). We also may use physical activity data through accelerometers, pedometers, heart rate monitors, and location trackers (Conger et al., 2022) to help us recorded our activities in a daily timeline. These sensor-based data are automatically collected but are often incomplete, particularly with regard to a student’s activity context. Siemens (2013) suggest including additional data through observation and human input to enrich data which may support holistic analysis. As a starting point, this research will investigate the use of various

data sources, combining automated tracking and self-declared data in Time Management application for students.

This chapter describes recent and relevant literature that served as the underlying theory for this study. The first section discusses the current time management app, development strategies, and various data sources that could provide significant information for display in students' time management apps. The following section discusses students' privacy concerns, the human-centred design approach, usability and user experience, mobile app development, and mobile app distribution for testing.

2.1. Time Management Apps

Time management is the ability to organise and plan how to manage ones daily schedule of activities with priority of achieving specified goals. For students, it helps to prioritise tasks so as to ensure that there is enough time available to complete every assignment. The quality of students' performance when doing such a task increases when they are not rushing to complete it ahead of a fast-approaching deadline.

2.1.1. Time Management Development Approach

There are studies that have explored the use of Time Management apps for higher education students. Hashim et al. (2020) developed the MySLT (My Student Learning Time) app to help university students to calculate and visualise their learning time. This app was designed as a supplement to the MySLT manual book, which guided the students at the university level to effectively manage their time for academic activities. Since the students felt that the manual book was bulky and inconvenient, the mobile app version of MySLT was developed to help students calculate the time needed for them to study based on their course schedule and course credit. The MySLT app was intended for students and academic advisors. The information covered in this app includes a list of subject hours, subject details, schedule and student learning time summary. The students were involved in the application usability evaluation and the students wanted to use the application in their daily life. This study did not use User-Centred Design (UCD), as a driver, the design and implementation being done by the researcher.

Khiat (2021) investigated the usage of automated time management enabled in a student LMS to explore students' learning efficiency and consistency. Learning efficiency is defined as the days needed for students to complete a course. Learning consistency shows the distribution of learning activities during the study period. The automated time management in the students' LMS was comprised of four features:

1. Visual Reinforcement. This feature displays the study plan schedule within the timeframe on the main page as the only access to LMS.
2. Adaptive release. This feature released the course material one by one in a sequential manner to help students avoid being overwhelmed
3. Learning monitor. This feature sends a personalised email to students containing notifications for weekly goals and reminders.
4. Learning motivator. This feature sends a personalised email to students complimenting students' good achievements and being encouraging when students' achievements are not as good.

A total of 36 students were invited to evaluate the LMS that already had the Time Management features. Their study shows that 17 students activated the Time Management feature and were able to complete the coursework in a shorter time.

These time management apps mentioned above were specifically developed for students to improve their time management during learning. The app concept and design came from the authors.. The students were invited only for app testing purposes. This condition may lead to a situation where the app does not rely on students' perceptions and expectations. To build an app that corresponds to students' expectations and avoids being rejected by them, we need to involve them starting from the conceptual stage of app development. By inviting potential users for discussion at the concept stage, we gain insight from potential users regarding their perceptions and expectation.

Liyanage et al. (2021) conducted a study to design an effective Time Management app for higher education students. They used a design-thinking approach and user-centred design to build high-fidelity prototypes of a smart digital personal assistant for university students. The ultimate goal was to have a useful and easy-to-understand set of UI designs that portrays the expected information to the students without losing essential points, while not displaying so much information that the students become frustrated. The target audience

for this work was students of the university who are reactive individuals and struggle with time management, prioritising studies and personal responsibilities. Surveys, interviews, and focus groups were used in the study and involved the students as the participants.

This study produced mobile app prototypes of an efficient time-management system for undergraduate students that is (a) simple to use and does not require a long lead time to understand and use. (b) meets the needs of reactive university students. A combination of User-Centred Design and Design Thinking methods was used to create high-fidelity prototypes, with user input at each stage. The study's findings provide insight into the time management issues that university students face. However, the students' feedback shows that they lack the grit and determination needed to finish the time-consuming initial setup process of the Time Management Tool. Students felt that having to enter all the details manually was a tedious job when they used the application.

Previous research by Liyanage et al. (2021) and Trujilo (2021) demonstrates the application of user-centred design in the development of a Time Management application for university students. Both studies depend on the participants' dedication to accurately record every aspect of their daily lives in the application. When students use the application and input all of their daily activity schedule information, they could face increased stress levels (Lund and Wiese, 2021). Evaluation of those studies was also done at the level of design discussion with the students by conducting interviews to obtain feedback and ratings from the students.

Because of advances in ICT, the smart device industry can now embed various sensors, processors, and memories in a smartphone. These devices are outfitted with sensors in order to improve usability and experience quality through data collection and analysis. Sensor data, on the other hand, can be processed using a variety of techniques to uncover hidden information in the age of big data and machine learning. The extracted data may aid device users, developers, and designers in better managing, operating and developing these devices. The extracted data, however, could be used to jeopardise human security and privacy.

In this study, we attempt to help university students track their time by using device sensors and tracking systems embedded in mobile phones. Using smartphone sensors, according to

Sano et al. (2018), aids in the time-consuming task of data collection. In addition, smartphone sensors can accurately record details that help self-reporting tools. When compared to studies that have traditionally relied on observations for data collection, passive measurements obtained through digital devices can enhance data collection (Kreuter, 2018). The passive collection of behavioural data via digital devices not only reduces the burden on the user by eliminating questions that would otherwise need to be asked in surveys, but it also allows for entirely new measurements.

While device sensors can help with data collection, they can also be a source of privacy concerns for users (Kreuter, 2018). In this study, we also looked at students' perceptions of privacy and incorporate them into the design of a time management app for university students. GDPR and research ethics requirements, in general, emphasise the importance of informing participants about the data being collected and why it is being collected. As a result, from the students' perspectives, an investigation into which data sources could be useful to support students' time management should be undertaken.

2.1.2. Various data sources for students' Time Management apps

In this study, we explore data sources outside the VLE that might be helpful for students' self-reflection in Time Management. There are five data categories which are explained below.

1. Library Access and Loan

   According to some research, more meaningful library interactions may aid in increasing student engagement, retention, and academic performance. The students' interaction with library services has been found to help to increase students' engagement, motivation and academic performance. This view is supported by Sakerudeen and Sanni (2017) that investigated the relationship between students' habits, which included library use, and their performance in Mathematics. Their findings showed that students who use the library's resources are more likely to achieve successful academic achievement than those who do not. As a result, there is a link between students' use of the library and their academic performance in Mathematics. This means that students' library use information may help students improve their academic performance. Similarly, Zhao et al. (2020) agree with this view. They explored a number of campus-based data sources to get a comprehensive picture of a student. They used multiple machine learning algorithms and data from multiple sources to predict students'

academic success. In their study, they reported the use of library entry and the number of books borrowed from the library as offline data sources to predict student success.

On the other hand, Gourley and Oliver (2016) suggested that learning is spread across many public and private spaces rather than being restricted to educational institutions and is connected as part of a consistent teaching process by the use of digital technologies. They reported that study space for students could be anywhere, and students felt that technology liberated them from having to study in specific places. The students and their learning space cannot 'bind' because of how learners, technologies, and practices move into, through, and out of such spaces. Carvalho and Freeman (2022) agree with this view. They recognize the range of campus spaces where learning can take place - in classes, library services, canteens, hallways, elearning systems, social networks, or the many non-campus spaces such as cafeterias, or working at home, or on public transport.

Unlike Gourlay and Oliver (2016), Beckers et al. (2016) argue that the preference of higher education students for particular learning spaces is influenced by the type of their study activities and subjects. According to the findings, students feel their physical learning space to be important and believe that the learning space influence the success of their studies. They reported that students choose to learn at home for individual study. Moreover, students prefer university learning spaces, including the library, for team study. Public spaces are not commonly used for study purposes. Overall, students prefer quiet learning environments such as a library where they can retreat as individuals or in small groups.

Hence, the university-provided learning space remains important since it supports students to connect with other people, schedules, and places associated with studiousness and academics. A study by Vichea et al. (2017) demonstrated that visiting the library is not merely about reading books. They distributed a questionnaire regarding students' perception of the usage of the library towards their academic success to 100 International students of the University of Cambodia. They reported 51% of students agree and 16% strongly agree that using the library improves their academic performance. The majority of students visited the library 1-3 times a week and 1-3 hours per session. Most of the participants (74%) responded that they visit the

library with friends. The students also acknowledged that they visit the library to get more knowledge, to get a good place to read books, to find reference materials and also to make new friends who love studying.

Recent research by Oyovwe-Tinuoye (2020) supported the views of Vichea et al. (2017) that students' reasons for visiting and using the library are varied. She conducted a study in the library of the Federal University of Petroleum Resources Effurun (FUPRE), which got 150 responses from library users. They revealed that the majority of the users were undergraduate students and the major reasons they visit the library are to do assignments, consult textbooks and reference materials, study for examinations, and use some library services, such as library printers, photocopying machines, digital board/projectors, and scanners.

Based on the above literature, library visits may or may not be perceived as useful information for students regarding information to display in their time management app. Asking these questions to students would help us reveal the students' opinions on whether the time usage in a library, either physical or digital, is useful information for their self-reflection in time management.

2. Class Attendance

Class attendance is still regarded as critical factor to get students' academic success. According to some experimental studies, having a clear attendance policy improves both student attendance and performance. Paisey and Paisey (2004) discovered a positive relationship between class attendance and subsequent academic performance. Their research discovered that many factors influenced students' attendance, including part-time employment, coursework work, illness, personal reasons (including hangovers), class schedules, medical appointments, lack of motivation, and so on. Their research also discovered that the greater the quality of students' attendance, the better their academic performance.

According to Zhu et al. (2019), student absences were negatively related to course grades. According to the findings of this study, an assessed attendance policy with proper consistency in the course description that emphasises the importance of attending lectures can motivate students to participate in class and be accountable for

their course outcomes. Students may conveniently look for reasons to miss class and therefore earn lower academic scores if their absence is not penalised. Likewise, Pinter et al. (2020) asserted that class attendance is frequently regarded as the primary indicator of students' persistence, whereas absenteeism is regarded as an indicator of the risk of dropping out. This view is supported by Sekiwu et al. (2020) claimed that variations in school attendance lead to variations in educational equity and success. Their empirical study found a statistically significant positive relationship between school attendance and academic performance (R = 0.365).

Although there is a positive relationship between attendance and academic performance, some studies do not support or agree with these findings. According to Grey and Gordon (2018), class attendance has no discernible effect on students' performance. They suggest that external motivators such as attendance can have unintended behavioural consequences. Enforcing attendance with extensive monitoring, such as registers or card readers, may lead to students attending but not engaging in learning. Furthermore, forced attendance may create negative learning barriers for students who feel compelled to attend lectures. They may use avoidance tactics in the classroom environment or disrupt the learning of others.

Grey and Gordon (2018), on the other hand, did not address class experience gained from attending class, which supports students' engagement in learning. Class experiences, including interactions with peers and the instructor, create a motivating learning environment that is essential for meaningful, lifelong learning. Furthermore, class attendance may encourage good work habits, teach responsibility, and improve social skills. According to Fitter et al. (2020), physical class attendance was rated higher than the other attendance methods in all aspects of study engagement. When compared to other learning methods, such as distance learning, in-person learning was perceived as more social and expressive of oneself. In-person class attendance also improved feelings of presence as well as interaction abilities.

According to the discussion above, class attendance may or may not be regarded as useful information for students' self-reflection in Time Management. By asking these questions to students, we can learn whether they believe class attendance is useful information for their time management app or not.

3. Web Browsing History

With its affordances, the Internet plays an important role in people's daily lives in the digital era. People, for example, use the Internet for a variety of purposes, including learning, information searching, socialising, and entertainment (Pandey and Pal, 2020). Universities have recently given students more convenient and straightforward access to the campus network in past decades. Students can use desktops, laptops, and smartphones to access the Internet at almost any place and at most every time while at university. The implications of Internet use on students' academic performance are still widely discussed.

Xu et al. (2019) highlight the potential benefits of Internet usage in the education field. Students' involvement in self-directed learning is enhanced by Internet use. Moreover, students with low self-efficacy do better in school when they learn new information or skills from the Internet. With the advent of MOOCs and E-learning platforms, there is an abundance of learning resources that contribute to students' academic success.

This view is supported by Sultan et al. (2020), who posit that the internet has refined and sharpened students' skills and capabilities, resulting in successful academic learning. From an academic standpoint, the internet is highly beneficial because it improves students' skills and capabilities, which aid them in their studies and professional lives. Sultan et al. (2020) assert that using the internet for collaborative learning has a significant and positive relationship on students' learning achievement. Their findings show that students' learning achievement is positively related to their use of the internet for learning purposes.

Despite the many benefits of the Internet, the lack of a clear distinction between learning and entertainment frequently leads to media-related attention problems, such as taking a long time to complete a learning task due to social entertainment distraction and the temptation to multitask. According to Emerick et al. (2019), social media can divert students' attention away from their studies and demotivate them from academic instruction and activities. When students use Facebook in class for reasons other than lesson participation, they claim they are simply multitasking. Nevertheless, studies

indicate that this "multitasking" leads in much poorer test scores and grade point averages (Emerick et al., 2019).

Similarly, empirical findings by Xu et al. (2019) claimed that academic success is dependent on behavioural discipline when accessing the Internet. They discovered that Internet connection frequency is related to academic success, whereas Internet traffic volume is related to academic failure. Furthermore, students who achieve academic success use the Internet for a more extended period of time. According to Xu et al. (2019), students from low-performance groups consumed higher Internet traffic volumes, implying that the students may always use the Internet for enjoyment with high Internet traffic, such as playing video games, using video chat, watching or downloading videos, and so on.

Digital distractions can interfere with goal achievement and lead to undesirable habits that are difficult to break. Biederman et al. (2021) highlighted use of the internet's potential benefits and risks for student learning. There are potential benefits, such as instant access to knowledge resources and the capacity to share information. In contrast, there are several ways for students to get distracted from their learning goals, such as by viewing interesting videos, perusing social media, or playing video games. Learning materials that are incongruent with the learner's goals and those that are congruent with their goals are easily available. Although learning may be unpleasant and tiring, distracting entertainment is meant to be engaging and addicting to encourage users to remain on a platform for as long as possible. Therefore, several digital self-control interventions promise to help people cope with the negative effects of digital distractions, such as app and website blocking, goal setting, and visualisations of device usage statistics.

Considering all of these references, it appears that web browsing history information has a significant relationship with academic success. This type of information could help students with self-reflection in their time management app. However, students' thoughts on how helpful their web browsing history information is for their time management apps have not been explored yet. As a result, in this study, we also investigated the students' viewpoints of their web browsing history information.

4. Self-declared and tracker-app data

   Smartphones are sophisticated machines that can function as personal assistants, monitoring our heartbeats and tracking our moves and positions. They frequently include an accelerometer, gyroscope, magnetometer, GPS, proximity sensor, ambient light sensor, fingerprint sensor, pedometer, QR code sensor, barometer, heart rate sensor, thermometer, and air humidity sensor, among other features. These sensors will be of great assistance in tracking human activity, such as jogging, heart rate history, counting how many steps and periodically saving activity history, and so on.

   Utilization data from smartphones and data streams from sensors (such as accelerometers, microphones, and GPS) enable constant and discreet monitoring of factors that are crucial to an individual's mental health (e.g., social interactions, location semantics, and physical activity). According to Sano et al. (2018), using the sensors on a smartphone may aid with the laborious job of data collection, which may take a lot of time. When compared to conventional observational research, passive measurements acquired via digital equipment may enhance data collection (Kreuter, 2018).

   According to Gong et al. (2019), context-aware mobile sensing systems have the ability to offer individualised healthcare treatments at the right time, in the right location, and in the right way. They used device sensors, such as accelerometer to measure students' movement and GPS to detect the students' location (e.g. home, school, office, etc). They found out that there is a significant difference in behaviors for individuals based on social anxiety levels and locations. Students with higher social anxiety symptoms exhibit more movement (as detected by the accelerometer), especially when they in an unfamiliar location (i.e., not home or at work). Research by Gong et al. (2019) shows that smartphone sensors may help passive measurements that collect data from students which is non-invasive and continuous.

   According to Rooksby et al. (2019), universities worldwide are confronting a mental health crisis. A growing amount of multidisciplinary research has shown that combining sensor and interaction data from students' cellphones may provide insight into stress, sadness, mood, and suicide risk, among other variables. This method, also known as Digital Phenotyping, has the potential to revolutionise the monitoring and comprehension of mental health and welfare. Using passive sensing, this technology

identifies and monitors abnormalities. Smartphones, social media, wearables, virtual learning environments, and other technologies all contribute to the data collection process. Rooksby et al. (2019) investigated some data obtained from smartphone that may be used in Digital Phenotyping, such as accelerometer, web history, battery, bluetooth, call logs, camera, screen, keyboard, GPS, light, microphone and SMS. Despite the potential benefits of Digital Phenotyping, students are aware of potential risks and privacy concerns. They stated that students are concerned about the security and privacy of data collected from their smartphone or wearable device. Part of the problem was that the data might be leaked from the university. Some students agreed they could trust their university to secure their data, while others were concerned about cyberattacks. However, students felt that their main privacy issue was whether all university personnel who knew or taught the student would have access to this identifiable information.

Taking into account all of these references, it appears that data collection from sensors embedded in smartphones has a high potential for passive measurements and unobtrusive tracking of students' activities. Data obtained from these sensors may be used to supplement students' self-reported data and assist time management apps. Students' perspectives on how useful information from smartphones and wearable sensors is for time management apps, on the other hand, have yet to be reviewed. As a result, in this study, we investigated the students' perspectives on their self-declared and tracker-app data.

5. Social network activities data

Online social networks (OSNs) are rapidly gaining popularity as a means of communication, particularly among students. According Sivakumar (2020), the majority of students in India who participated in their research spent 3-4 hours per day on social networks. Similarly, Kolhar et al. (2021) stated that the majority of Pakistani students who participated in their survey spent more than 3 hours per day on social networks in their spare time. The majority of those who took part in the studies said they had used social networking sites for non-academic and recreational purposes. These habitual behaviors, furthermore, can divert students' attention away from their academic goals, affecting their academic performance, interpersonal relationships, and sleeping habits.

Moreover, many young adults use their phones before going to bed, which causes hyperarousal, reduces sleep quality and may result in sleep loss. Sleep deprivation is becoming increasingly common, and it has been linked to late-night use of online social networks, tv watching, and online games. Kolhar et al. (2021) found that 39% to 45% of students slept for shorter hours than strongly advised due to late-night social network use. This could result in a relatively late bedtime, lost sleep, and irregular sleep-wake patterns. Sleep is a restorative process that is essential for good health. Sleep deprivation harms health, including mental wellbeing, by impairing brain ability, motor processes, and emotional stability. Sleep deprivation is also linked to an increased risk of metabolic disorders such as overweight, high blood pressure, and diabetes (Levenson et al., 2016). Another negative impact is social networks addiction, which leads to unhealthy habits and physical inactivity among students, putting them at risk for physical diseases and mental health problems (Kolhar et al., 2021).

However, many researchers believe that the use of social networks today provides the benefits of networking while also serving educational purposes in a modern manner (Ansari and Khan, 2020; Alharbi et al., 2020; Almutairi et al., 2022). Students of all ages are increasingly using technology as part of their academic experiences. As a result, academic staff believe that social networks can be used to actively engage students in tertiary study and university course content. Ansari and Khan (2020) assert that the use of digital social networking sites for collaborative learning enables students to be more creative, dynamic, and research-oriented. They claimed that the usage of social networking platforms for collaborative learning had a significant impact on interactions with peers, instructors, and digital information sharing behaviour. Furthermore, students' participation has been significantly impacted by contact with instructors, classmates, and digital information interchange, which in turn has had a big impact on students' academic progress.

Alharbi et al. (2020) reviewed the literature from 2007 to 2019 and discovered that undergraduate nursing students used social networks for a variety of reasons, including keeping in touch with others and entertaining themselves, promoting learning, finding support networks, developing a professional nursing identity, sharing their experiences as nursing students, and finding job opportunities. It helped students not only for

personal lives, but also for their academic and transition to practitioners. Almutairi et al. (2022) also conduct a systematic review of the literature from 2005 to 2020. Data from sixteen multiple researches were extracted and thematically synthesised. This review found that using social networks to support nursing students' learning has a positive impact on students engagement, communication and interaction. In addition, they said that the expansion of social networks has favourably impacted the area of nursing education by providing a virtual learning environment and enhancing cooperation and teamwork regardless of time and location limitations.

Taking into account all of these references, the advantages and disadvantages of online social network, it seems that data collection from students social media has a high potential for assisting students self-reflection in time management. Data could be obtained from a tracker app that is embedded in students' devices. Students' perspectives on how useful information from their social networks account and the data privacy, on the other hand, have yet to be reviewed. As a result, in this study, we investigated the students' viewpoint on the usage of their online social networks information for students' time management app.

2.2. Students' view of their data privacy

Universities are rapidly adopting networked information technology. This enables campuses to function as a hidden layer of interconnected pervasive systems that support complex institutional administration and interpersonal communications, enabling face-to-face and e-learning experiences, resource availability, and campus security (Jones et al., 2020). On a regular basis, these frameworks gather and maintain information about their populations. When faculty, staff, and students log in to these systems, click on resources, and submit information, their activities and material become data records. Many of these data identify individuals because institutional systems frequently request credentials for access. All aspects of this metrics activity must be carried out with consideration for the ethical and privacy concerns inherent in collecting data, evaluation, and preservation (Corrin et al., 2019).

Higher education institutions are growing their ability to perform learning analytics, which is a social and technical big data practice. By using the increased availability of big datasets

around students' contextual information, both collected and shared, learning analytics may extract more knowledge than the currently available data. For example, by connecting and analysing the vast amount of collected data, we may find correlations between student activities (either on weekdays or at the weekend), student academic performance, and student well-being. Students may benefit from the research, e.g. when a student notices that most students have regular activities in the Student Union during the weekend to maintain their well-being, an individual student might be more motivated to do the same thing.

However, students are rarely informed about data analytics practices that use their data, and there are significant privacy concerns (Jones et al., 2020). As new streams of students' personal data prevail and more detailed information about students becomes accessible, there is a growing need to resolve students' privacy and related problems. Student privacy is an essential issue among educational theorists, academic information policymakers, and the media. They asserted that using predictive analytics and the digital data infrastructure that supports analytic practice may impair students' capacity to protect their privacy (Jones and Afnan, 2019).

Because of the situational context between the university and the student, privacy is an essential aspect of higher education (Corrin et al., 2019). Many scholars have attempted to define privacy functionally because it is normative and sometimes personal. The functional integration of a student's preference to reveal or preserve personally identifiable information is referred to as privacy management (Yang et al., 2016). Consent is the power to exercise authority, which may or may not be violated by assaults on privacy, such as societal expectations or perceptions that reluctant approval will hinder the student's academic goals (Jones et al., 2019; Shane-Simpson et al., 2018). As addressed in two previously published studies on public online privacy (Barth and de Jong, 2017; Gerber et al., 2018), the link between data protection management and consent is known as the "privacy paradox".

Colleges and universities must first inform their students concerning educational privacy policies and how students' information is preserved and may be used in the future, including possible future harms and benefits. Jones and Afnan (2019) found that universities must take coordinated action to restore moral congruency with students' needs. This is similar to the existing literature on students' perspectives regarding their

digital privacy (Schumacher and Ifenthaler, 2018; Bennett and Folley, 2019; Slade et al., 2019; Whitelock-Wainwright et al., 2019). The findings confirm that students (a) are not apathetic about their private information; (b) prefer to participate in privacy choice; and (c) have articulated and diverse views on accessing information, regulation, and data ownership (e.g., no sales of "my" data).

Furthermore, higher education institutions have authority and frequently eliminate the component of consent from processes that reduce student privacy, which affects students' perceptions of the institution, according to Jones et al. (2020) who reported findings from over 100 discussions with university students about their privacy attitudes at eight different colleges and universities in the United States. Students were unaware of educational computational intelligence and data analytic practices, along with the data they heavily depend on. Students see opportunities in higher education data analytics, but they need substantial evidence of when and to whom to disclose their data. Furthermore, students also explain why the consent form is critical and essential (Jones et al., 2020).

The research focus on privacy beliefs and behaviours is examined from a variety of angles in the literature. Ifenthaler and Schumacher (2016) confirmed that students' intention to share personal information with the university is related to their expected use of learning analytics. According to their findings, students are unwilling to share their medical information, income, and externally generated data, such as social media and marital status. Furthermore, concerning the users' perception of privacy in quantified-self services, Leibenger et al. (2016) reported that most of the respondents in their study were concerned about the transfer of health, location and financial data under their real identity. They were even worried about transferring their data under a random pseudonym (for health, location and financial data).

Xie and Karan (2019) investigated the relationship around influence factors such as technological acceptance, knowledge and understanding and the privacy behaviours of university students. Their results reveal that students' attitudes differ according to the kind of data revealed and also that trust was more significant than privacy concerns (Xie and Karan, 2019). Avuglah et al. (2020) interviewed university library staff and students to learn about their privacy values and expectations when using online library resources. Both

group sessions agreed that students should have the ability to manage who has access to private data and that library usage monitoring should be truthful (Avuglah et al., 2020).

Even if higher education data analytics practices lack integrity (in terms of privacy), all is not lost; all that is required is careful consideration and strategic action to promote student privacy and informed consent. Institutions must implement a collaborative design process that authentically and strategically incorporates student involvement to begin restoring contextual integrity. Co-designing regulations, procedures, and technological innovations will create a continuous feedback loop for universities and their representatives, forcing them to express their ideas and be clear about their targets. As a result, universities will become more sensitive to students' privacy concerns, and students will be more cooperative and willing to trust universities' data analytics initiatives.

Hence, we need to gather students' expectations and requirements before developing an app that supports students doing self-reflection on their Time Management. There is an opportunity for students to disclose their personal information in this app to others, such as personal tutors, university and their peers. This study explores the students' perceptions and expectations, such as privacy preference, what kind of analysis the students would like to have, and to whom they want to disclose their data.

2.3. Human–Centred Design

The focus of computer applications and systems development used to be thought of as employing advanced technology to meet business goals. However, designers' mindset has changed nowadays with making everyday things usable as their main goals. This raises a crucial question for designers about how to innovate rapidly, in the right ways and fulfil the expectation of users. To answer this problem, designers should immerse themselves in the lives and perspectives of real people to understand their needs, motivations, and feelings. By continuously creating prototypes and seeking feedback from their users, designers build things that are not only advanced but also acceptable.

2.3.1. Human–Centred Design Boundaries

Human-centred design is the mindset of putting the user of the application rather than the application itself at the centre of the design process. What it simply comes down to is

always considering from the perspective of the human and continuing to explore, model, and build solutions that never require the user to remember what they should do next. Human-centred design helps designers gain insights into who their users are and how their users' behave. Designers may use this knowledge to assist them in their design process. Gall et al. (2021) reviewed seven methods that could be employed in human-centred design. Below is an overview of those seven methods.

1. User-centred design

   User-centred design (UCD) is a human-centred design approach that puts the users at the centre of the design process. Since user-centred design always thinks from the users' perspective, the solutions would never make the users need to think about what they have to do next. In other words, the aim of the UCD approach is to create a highly usable and accessible product for users (Interaction Design, 2020). This approach developed at Donald Norman's Research Laboratory at the University of California, San Diego, in the 1980s. UCD emphasises user needs and involvement throughout the design process, which may combine with agile, waterfall and other software engineering methods (Liyanage, 2021). UCD have an iterative design process which covers planning, design, implementation, and evaluation.

2. Persona-based design

   Persona-based design is a human-centred design approach that involves users in the design process. People can differ from each other in their personalities, so their motivation and preference for using the software may vary. Therefore, persona-based design is used to create a starting point to satisfy as many personalities and preferences as possible (Shahri et al., 2016). Persona-based design can assist developers in avoiding cold starts in designing and elicitation analysis. Furthermore, using a persona-based approach may support software engineers in obtaining feedback from enhanced representations of users (Gall et al., 2021).

3. People-centric design

   People-centric design is an alternative approach to user-centred design that focuses on people and the general public's point of view. This approach emerged in the 1960s urban design field and was popularised by Gehl (2011). People-centric design refined human-centred design, allowing designers to have a more humanised view of the people for whom they design. The people-centric design follows four principles: people-

centred, focus on solving the right problems, everything is a framework, and narrow and simple initiatives (Norman, 2022).

4. Inclusive design

   The inclusive design approach focuses on the contribution to understanding user diversity by including or excluding users and emphasising specific user involvement throughout the development cycle (Fuglerud et al., 2020). This approach is similar to the previous approach in many ways, but it emphasises observation and problem situations in design to achieve better outcomes for all entities (Reis Santos, 2021). According to Treviranus (2019), the inclusive design approach would result in more appropriately accessible design, such as for people with disabilities.

5. Participatory design

   The participatory design approach involves the users from the early concepts or initial discovery, so the users take an active role in co-designing solutions for themselves. Conducting co-design with real users can reveal unexpected problems that may not arise in interviews or simple quantitative data.

   Participatory design refers to design processes in which the user plays an important role. This can take many forms, from quick polls at the start of the process to recurring group sessions, including user and stakeholder (Bertolini, 2020). While participatory design emphasises people's direct participation, the design process is kept separate and is only made aware through the communication process. As a result, participation can occasionally turn into a simple option or a required element without the outcomes in subsequent stages being linked (Gall et al., 2021).

6. Collaborative design

   Co-design, or co-creation, is the next level of active participation. The term 'co' stands for collaborative, or the open, simultaneous and horizontal collaboration of creators and users. Co-production as an aspect of co-creation, for example, through the narrative structure (Gall and Haxhija, 2020), or consultation, negotiation, and general agreement practices, are examples of extended conceptualisations (Watson, 2002, 2003).

   Collaborative design is a social practice in which participants relate to the task's dynamic and iterative nature and where results emerge from the interactions of those

involved (Peters et al., 2021). This approach requires people from various fields from the beginning of a project. Using user collaboration design keeps designs in check, both in terms of quality and accessibility.

7. Decentralised design

   Finally, a decentralised design approach in response to current trends, such as the idea of prosumers (serving both as the producers and consumers), is enabled by new technologies and values (Navio-Marco et al., 2022). This approach describes a process in which neither the creator nor an outside professional participates actively. The function of a facilitator, for example, is becoming obsolete as device connection gets better through more straightforward procedures. While this may not be applicable across many conditions right now, it could be in the years ahead. A typical example is the ability of 3D printing to enable decentralised design and manufacturing (Urry, 2016).

   Decentralised design, on the other hand, refers to a broader field than the current design process and other initiatives centred on 3D printing. When imagining future design approaches, post-automation could add another layer by describing a period when most essential functions would be automated. Moreover, the general public would have direct connections to design and production infrastructure, a richness of interest and time or even a need to create and begin producing objects (Gall et al., 2021).

Gall et al. (2021) proposed that the human level of participation in design approaches may be related to the product or service's impacts. They summarised the boundaries human-centred design approach, as displayed in Figure 2.1.

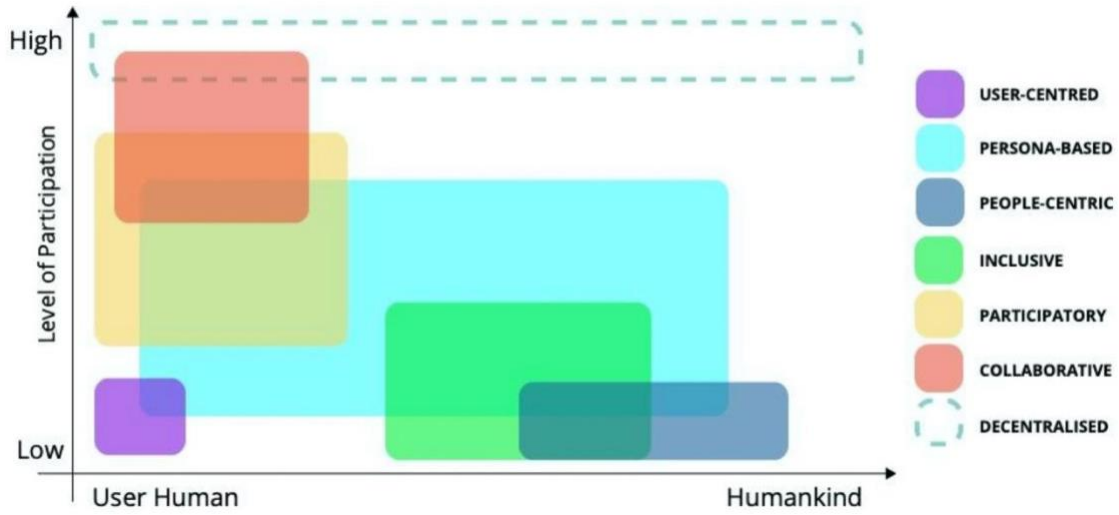


Figure 2.1 Boundaries of the human-centred design approach

The x-axis represents the impact of various human-centred design approaches on humans, ranging from the user human on the left to humankind on the right. The y-axis depicts the levels of user participation, which range from low to high. The degree of user involvement in human-centred design approaches may be related to user expectations and feelings of ownership. Users can be co-opted into the design process as full or partial participants.

Each situation has advantages and disadvantages. If users opt for full participation in the project, their input will be consistent, and they will become very familiar with the system and its logic. However, if the project takes a long time, a user may not be able to participate in it fully. According to the circumstances, this will require careful handling because the user will be attempting to acquire knowledge as a design team representative while also fulfilling the pressures of their actual job. Individuals may become highly stressed as a result of this. As a result, some users may be co-opted as participants in the design process.

Based on Figure 2.1, user-centred design is a human-centred design approach that has lower user involvement. In user-centred design, the design product is conducted by designers considering users' needs. User-centred design has a broader context where the design teams involve users throughout the design process using a variety of methods to create a highly usable and accessible product. Moreover, the terms user-centred design and participatory design are often used interchangeably or complement each other (Wallisch and Paetzold, 2020). According to Gall et al. (2021), participatory design and collaborative design have

a higher level of user contribution in the design process. In those approaches, users devote their time and work together with the design team to create a usable design.

Furthermore, Gall et al. (2021) also suggested that in most cases, choosing one approach to design is not sufficient. Therefore, a combination of these design approaches must be carefully considered as it is situation dependant (Sturm and Tscholl, 2019). When the users cannot be fully involved with the design teams for some reason, e.g. time-constrained or overburdened (Farao et al., 2020), then a user-centred design approach is more suitable as the design team still considers users' needs by putting users' view as the heart of design process. Moreover, Farao et al. (2020) suggested to add the users' level of participation, a collaborative design or participatory element may be combined with a user-centred design process.

2.3.2. User-Centred Design

This user-centered mindset is a frequently overlooked aspect of digital product design that deserves far more attention. We can create more successful digital products with a solid foundation of knowing users' needs and goals and understanding what a positive user experience means to our users.

UCD is an innovative field with a wide range of languages and approaches. Still and Crane (2017) introduced RABBIT as the key steps in user-centred design. RABBIT usage is flexible, there are a lot of things involved in each step, and sometimes they may not be all used. The explanation of RABBIT is an acronym and the explanation is below:

- **R**esearch users.
- **A**ssess the environment, the project goals and requirements, and the competition.
- **B**alance user needs and affordances with your team's
- **B**uild out an operative image / prototype for users to interact
- **T**est the image / prototype bwith users to gather feedback.

We do not have to follow RABBIT in order, and sometimes methods or techniques found in one of them can be repurposed in another steps.

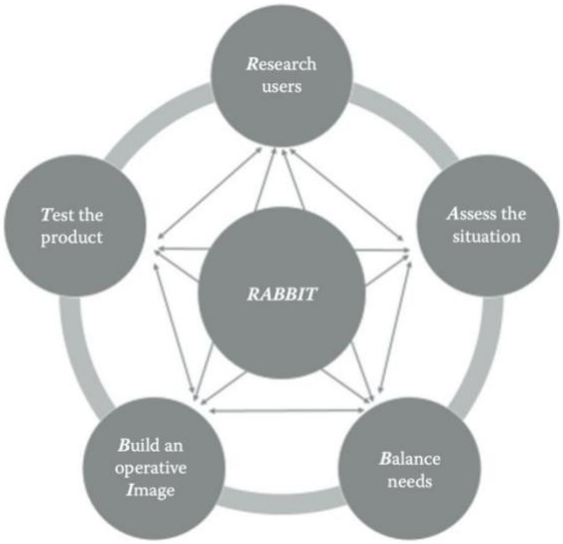


Figure 2.2 The RABBIT process (Still and Crane, 2017)

Knight et al. (2018) suggested some key steps for developers to implement user-centered design:

- Balance the business objectives and user needs
- Adjust the developer perspectives
- Focusing on the user and build empathy
- Develop visual design and prototype it
- Evaluate the prototype and iterate

Kanungo (2022) proposed key steps in ideal user-centered design workflows which seem similar to Knight et al. (2018):

- Comprehend and gain users' perspectives
- Ideate by sketching and wireframing
- Design the high-fidelity prototype with with all the visual elements of design
- Implement the final design and developer handoff
- Improve the design by test, update, iterate

Considering the previous literature, there are common steps in User Centred Design which include:

- Recognizing the users

  The UCD process begins with identifying potential users, or people who will benefit from the design. Studying user research findings from user interviews, focus groups,

and surveys allows us to better understand users' problems, needs, behaviour, and preferences (Kanungo, 2022).

- Strike a balance between business objectives and user requirements.

  We have a complete set of features, a lot of information, and a wish list of possible options that need to be filtered as a result of the previous steps. To accomplish this, we must go through the wish list items, goals and needs from users, goals and needs from the business and stakeholder, and finally situational factors (Still and Crane, 2017).

- Create the prototype

  When ideation workshops and exercises are held, users are invited to get involved. We occasionally learn about new possible options from the users' view that many of us were not aware of. Prototypes can be created based on co-design workshops (Kanungo, 2022). When presented to end users, these prototypes serve as a representation of the final design.

- Evaluate, Improve, and Iterate

  A design's journey begins and ends with its users. The views and opinions of users on the final and initial design are critical to the continuous evolution of the design process. To validate a design and check if the users satisfied, we may conduct a usability testing.

2.4. Usability and User Experience

In both academic and industrial research, the success of any product for human use is determined by the user's experience based on their interactions with the product. It is dependent not only on the product's ability to serve the user with capabilities that meet his requirements and objectives effectively and efficiently but also on the user experience. User-Product Interaction (UPI) is an important field of study in Human-Computer Interaction (HCI), focusing on two key concepts: usability and user experience.

User experience has become the most important design process in recent years. And the term usability is also important in enhancing user experience. User experience, in its broadest sense, includes achieving behavioural goals, satisfying non-functional or hedonic needs, and acquiring pleasant perceptions and well-being. A person's subjective feelings and attitudes toward using a particular item are referred to as user experience (Hassenzahl et al., 2006). The functional scope, product brand, psychological expectation,

and actual emotional feeling are all included. These are critical components of the user experience.

Furthermore, usability is divided into task-oriented and achievement categories. The usability of engaging IT products is an important factor that must be considered. It refers to how well products are effective, easy to learn, quick to use, convenient, have low error rates, and satisfy customers. Usability is primarily concerned with the functionality of the product. An application's usability goal is to be "easy to use." In contrast, the goal of user experience is to focus on the user's entire experience before, during, and after using the product. As a result, usability is concerned with how easy it is for the user to complete the task while using the apps, whereas user experience is concerned with how the user perceives the human-applications interaction.

In conclusion, usability can be viewed as a component of user experience, which is the heart of user experience and fulfils each other. Table 2.1 summarises the relationship between both Usability and User Experience as defined by Hassan and Galal-Edeen (2017).

User Experience		
Usability		
Task-related	+	Non-task related
Pragmatic interaction		Hedonic interaction
Do-goals		Be-goals
Instrumental qualities		Non Instrumental qualities

Table 2.1 Usability-User experience relationship summary (Hassan and Galal-Edeen, 2017)

Additionally, Sauer et al. (2020) noted that usability evaluation uses a wider variety of techniques, including user-based and expert-based approaches. In contrast, user experience frequently employs user-based and subjective methods rather than an objective approach. Table 2.3 summarises the methods used to apply usability and user experience concepts.

Method	Type of Data	Usability	User Experience
User testing	UB, QL, QNT, OBJ	***	***
Checklist	EB, QNT, OBJ, SUBJ	**	*
Heuristic evaluation	EB, QL, QNT	**	*
Questionnaire	UB, QNT, SUBJ	***	**
User reports and complaints	UB, QL, SUBJ	***	**
Thinking-aloud technique	UB, QL, SUBJ	***	**
Cognitive walkthrough	EB, QL, SUBJ	**	*
Automatic checking	EB, QNT, OBJ	*	*
User observation	UB, QL, QNT, OBJ	***	**
Psychophysiology	UB, QNT, OBJ	**	**

UB:user-based, EB:expert-based, QL: qualitative, QNT: quantitative, OBJ: objective, SUBJ: subjective.

Table 2.2 Overview method employed in usability and user experience (Sauer, Sonderegger, and Schmutz, 2020)

2.5. Mobile App Development

Recently, mobile industry technology has become increasingly diverse. Each vendor has its own non-standard method for building applications for its handsets, which employs a variety of programming languages and SDKs. The smartphone market is getting dominated by two platforms: Android (from Google) and iOS (from Apple). Apps created using traditional development methods for one platform only work on that platform; therefore, enabling multiple platforms may necessarily require creating the apps individually for each platform. Full-native, web-based applications and hybrid applications are the three main development methods[5].

Full-Native Applications

Full-native applications are developed using different languages and development environments in each context. From a performance and UX perspective, this choice has less risk. However, since there is no code sharing in full-native app development, it may have a higher potential cost if we target multiple platforms. There are frameworks for fully native applications: Swift/Objective C (for iOS) and Java/Kotlin (for Android).

[5] https://www.mobiloud.com/blog/native-web-or-hybrid-apps/

Web Applications

Web applications are a type of website that is specifically designed for mobile devices. Web applications are accessible via a device's browser and work on all platforms. Website development and mobile web application development are very similar. Web apps have limited access to the device's functionality because they perform in an internet browser. They do not have explicit access to low-level APIs provided by provider systems to native applications, such as storage, sensors, camera, and Bluetooth (Charland and Leroux, 2011).

Hybrid Applications

Hybrid applications use web technologies, but they, like native applications, must be installed on the smartphone. Cross-platform tools are used to create hybrid apps. Cross-platform development allows developers to lessen development and support costs by distributing code between platform deployments (Martinez and Lecomte, 2017).

Based on the above description regarding mobile development method, hybrid applications beat full native applications in terms of development and maintenance cost. For this reason, the mobile app in this study will be developed using hybrid technology.

2.6. Mobile app distribution for testing

App testing is an essential part of the app development process. We can run tests on the app on a regular basis to ensure its accuracy, usability, and functional behaviour before releasing it to the public. Mobile applications are becoming increasingly sophisticated, requiring careful end-to-end testing to ensure the application is easily downloadable, works smoothly, and provides the same experience on different equipment.

The goal of testing a mobile app is to see how it behaves in different environments. Given the numerous limitations of simulators, many test engineers believe that testing on real smartphones is far more beneficial. Simulators can be useful in the early stages of testing, but validation on a smartphone is more reliable. However, it is an expensive option that necessarily involves a significant investment.

Furthermore, to release an app to end clients, developers must adhere to the prerequisites of mobile application stores (e.g., Google Play Store, AppStore). These requirements change over time, and developers need a way to test their apps' compliance. Installing the tested app to specific devices, such as iPhones, is more difficult than necessary (Joorabchi et al., 2013). Currently, there is no standardized approach for evaluating a smartphone application across several platforms. As a result, each platform must be individually tested.

2.6.1. iOS app testing

To submit beta app test builds to Apple, the app must have an App ID generated in both the Developer Portal and App Store Connect. Becoming an Apple Developer is free and gives us a lot of access to information. However, to submit an app to the App Store, we need to pay a fee to enrol in Apple's Developer Program.

To submit the app builds, we need to archive the app and then upload the archive to App Store Connect. After the apps' beta builds are available on App Store Connect, the rest is the set-up work on TestFlight. TestFlight allows sending the production-ready app to up to 10,000 testers by either sharing a link or emailing their Apple IDs.

Apple recognises two types of TestFlight testers:

- Internal Tester: An App Store Connect user with the Admin, App Manager, Legal, Developer, or Marketer roles to access our app. We have the capacity to add up to 100 internal testers, with each participant can testing on up to 30 devices. To add internal testers, we must send them an email (using their Apple ID) inviting them to accept the invitation.
- External Tester: Any user outside of the team who wishes to test the app. External testers do not have entry to our App Store Connect account and are only able to download and install the app. We have the capacity to add up to 10,000 external testers.

Before external testers can evaluate an app, we should submit it to Apple for assessment, just like any other App Store entry. These reviews are typically faster than regular app reviews, but there is no guarantee. We could send our software to external testers once it has been confirmed. When App Store Connect has finished processing a build, it notifies all internal testers. Furthermore, external testers are notified after Apple completes a beta app review to ensure the app complies with the App Store Review Guidelines.

2.6.2. Android app testing

As an open platform, Android offers choice, so we may distribute the Android apps to users in any way we want by publishing in an app marketplace or emailing them directly to users. Android is never locked into any particular distribution platform. Usually, to reach the broadest possible audience, the mobile app is distributed through a marketplace. Google Play is the premier marketplace for Android apps and is particularly useful for distributing the apps to a large global audience. However, Android apps can be spread through any app marketplace or use multiple marketplaces.

Furthermore, sending the app to users via email or any other communication channel, such as WhatsApp, is a simple and quick way to publish them. The Android method detects the APK and displays an Install Now button whenever the users access the email on their Android device. By pressing the button, users can install the app. Users must consent to the installation of unknown apps. Emailing the app to a few trusted users is convenient, but it provides a few protections against intellectual property theft and unauthorised circulation.

Spyware for Android has significantly increased since Android is an open source platform (Shrivasta and Kumar, 2019). As a result, the intruder distributed malicious programs in a variety of ways, including malicious applications, repackaged applications, cloned applications, etc. Both the volume and sophistication of Android malware have been constantly rising. Android applications ask for a wide range of permissions in order to function securely, however not all of these programs can be relied upon to protect our data. The data and information may be used by various third-party programs to harm the user.

The AndroidManifest.xml file for the program contains a list of all the different permissions that are used during the installation process. As soon as the permissions are granted, they remain in effect until the application is upgraded or uninstalled. The user is not permitted to remove an application's permissions. A feature to alter permissions was added in Android version 4.2, but it was later removed to prevent software crashes. The permissions system in Android 10 received a couple new layers on top of what was already there (Cao et al., 2021). Android 9.0 Pie's permission mechanism remains mostly unchanged, however, the extra features allow us better privacy and more control. The ability to grant Android 10 permissions only while an app is active is the first significant change. The majority of the

time, it's reserved for critical permissions like geolocation, microphone, and similar permissions. So, while the program is running in the foreground, we can provide the app to access to users' location. The app shouldn't theoretically be able to determine users' location when it's not being used.

Chapter 3. Methodology

This chapter discusses the research design and methodology employed in this study. The study's research design, which consists of research phases, data collection techniques, and data analysis techniques employed at each stage, is covered in the first section. The following section covers ethical considerations and declarations of conflicting interest. Finally, reflections on the methodology used in this study are also considered.

3.1 Research Philosophy

There are three main frameworks for designing research methodologies: the mixed methods approach, the qualitative approach, and the quantitative approach (Ajimotokan, 2022). Quantitative research has certain important advantages, such as the ability to evaluate correlations between relevant variables, test the study's hypothesis, and do group comparisons (Mohajan, 2020; Bloomfield and Fisher, 2019, Roni et al., 2020). However, qualitative research has the advantage of presenting findings in fresh, real-world contexts like the emotions, opinions, and behaviors of actual people (Gronmo, 2019). Given that both research methods have their strengths, mixed-approach research holds out the possibility of bridging both traditions and combining both methods' advantages (Ajimotokan, 2022). The main premise of the mixed methods approach is that, compared to using any one method alone, it provides a better comprehension of the study problem and/or questions. Mixed-method research is gaining prominence worldwide. When dealing with numerical and human experience, it leads to more diverse results. Mixed-method research can strengthen and enrich study results by mixing quantitative (e.g., closed-ended response data) and qualitative data (e.g., open-ended personal data) (Creswell, 2015; Reyad et al., 2020).

A mixed-methods approach is usually employed when exploring user-centred design research (Risling and Risling, 2020; Archibald et al., 2021). Schrader et al. (2020) reported that a mixed-methods approach is often used within Human-Computer Interaction (HCI) and design research to collect and analyse quantitative and qualitative data. User-Centred Design (UCD), which addresses both technological and behavioral issues in people,

operates in this HCI context. Various methodologies allow for the examination of qualitative and quantitative data in UCD research (Göttgens and Oertelt-Prigione, 2021).

3.2 Research design adopted in this study

When using mixed methods, scientists must decide on a research strategy that directs their information gathering, evaluation, and interpretation (Creswell and Clark, 2017). Several typologies describe mixed methods designs in the literature (Teddlie and Tashakkori, 2010; Creswell, 2015). According to our study's goals and scope, a mixed-methods strategy was chosen to collect qualitative and quantitative data in our user-centred design research. Identifying challenges and user requirements for students' personal time management tools requires quantitative performance data and qualitative behavioral and attitude observations. Designing quantitative and qualitative research is challenging. Because of the underlying complexity in mixed-methods designs, this approach is significantly more challenging. Researchers need to be mindful of their approach and flexible when using mixed-methods designs, which may be fixed or emergent.

There is some research that involved students in UCD using mixed-method principles. De Quincey et al. (2019) usedmixed method when involving students in designing the dashboard of a learning analytics application. Their investigation attempted to understand why students desire to study at university and mapping their engagement, with weekly customised alerts and feedback. In the proposed design, when it comes to data visualization, students can choose between viewing the data as a chart or as a representation of themselves. According to a mixed-methods review in this study, students' perceptions of the reliability and trustworthiness of the underlying analytics and data have been found to be varied. Tsai et al. (2020) used a mixed-method approach in an investigation of student expectations towards learning analytics privacy issues. The approach was taken in order to validate between the online questionnaire results and focus group discussions. Ramadhina et al. (2019) also used a mixed method approach when designing an online course using a UCD approach. The study comprised of requirements analysis, design creation and prototype construction which then was assessed by potential users and an expert reviewer. Considering the feedback from users and the expert, 17 functionalities were present in the final application out of the 34 user needs identified. Ramadhina et al. (2019) reported that a mixed method approach is useful for research where using qualitative or quantitative data

alone is not sufficient to answer the research questions, especially for research that involves human participants. The use of mixed methods gives a voice to study participants and ensures that the study's findings are grounded in participants' experiences (Dawadi et al., 2021).

Considering the above-mentioned literature, our study adopted a mixed-method approach since our research focus is on user-centred design (Figure 1). The purpose of using a mixed-method approach in this study is to collect rich and comprehensive data and also reflect on participants' points of view. Our study employed a series of requirements analysis and modelling techniques and evaluation, which is broadly separated into five stages (Table 1).

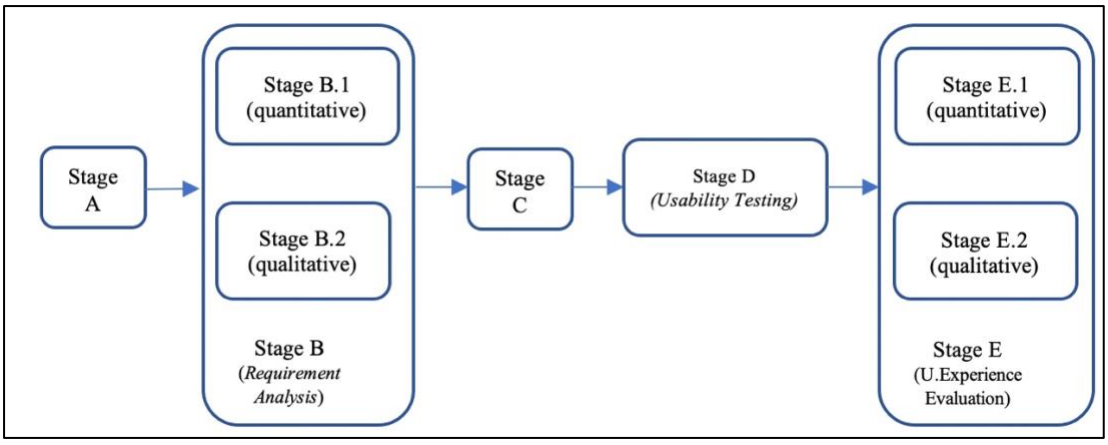


Figure 3.1 The mixed-method research strategy adopted in this thesis

Typically, theoretical frameworks are used to guide and lead empirical (mixed-methods) research (Creswell, 2014). Therefore, our first step of this study (Stage A) consisted of a literature review, which aided in refining the study's scope and selecting a suitable research design.

Stage	Method	Research Approach	Why	Where/ With/ whom	How/Analysis
A	Literature review *(Ch. 2)*	--	Needed for theoretical basis of the study	Research laboratory	Reading time management analytics (data sources, ubiquitous

					technology, users' privacy), user-centric design, and mobile application
B	Requirement Analysis				
B.1	*Online* Questionnaire *(Ch. 4)*	Quantitative	Needed for identifying user perception and needs on using data outside VLE to help their self-reflection	Newcastle University students	Data Visualization
B.2	Focus Group Discussion *(Ch. 5)*	Qualitative	Needed for identifying users' preferences and reasoning to identifying design consideration	Newcastle University students	Thematic Analysis
C	Design Concepts and Artifacts *(Ch. 6)*	--	Needed for translating requirement into specific design to answer research question	Research laboratory	Implementing design as prototype (high-fidelity wireframe)
D.	Usability Testing (Thinking Aloud Protocol)	Qualitative	Needed for user feedback regarding design to understand users' opinion and preferences towards prototype	Newcastle University students	Thematic Analysis
E	User Experience Evaluation *(Ch. 7)*				
E.1	UEQ questionaire	Quantitative	Needed for systematic identification user interaction problem with the apps; to integrate data from all research stages and to enable triangulation and holistic under-standing of the whole project stages	Newcastle University students	Numerical Analysis
E.2	Open-questions survey (retrospective feedback)	Qualitative		Newcastle University students	Thematic Analysis

Table 3.1 Research stages and methods in this study

The use of qualitative and quantitative data in Stage B was considered beneficial and in line with the objectives and our first research question mentioned in Chapter 1. In our study, quantitative methods (Stage B.1) were used to narrow and prioritize user preferences. Then, users were asked to evaluate several existing systems that are similar to the expected solution in a group discussion (Stage B.2). Examining several available systems helped users to figure out the app design and identify potential problems (Garbuio and Lin, 2019). This qualitative method is used to gain more insights from the quantitative findings obtained. In stage B2, participants were also asked to design the app screen. The screen designs from participants represent the app features they would like to have. Then, the designs from participants and their feedback from Focus Group Discussion were summarised as design considerations. In stage C, a more interactive prototype was created using the design considerations from stage B.

In Stage D, participants were asked to evaluate the interactive prototype from stage C. At this stage, usability testing is used to reveal users' opinion and preferences on the application scenario, navigation and UI design. The findings from stage D are then used as guidelines in the further stage to develop the mobile application.

There is a user experience test to follow up on the mobile application development. In this assessment, users evaluate the apps in a real environment setting by doing several predefined tasks. Stage E.1 is conducted to measure the comprehensive impression of user experience by filling out a standardized questionnaire, while qualitative method (Stage E.2) aims to complement the findings from stage E.1.
Each of the five research stages is further described below.

Stage A. Literature Review

Designing a useful mobile app is a complicated research challenge that may be viewed from different theoretical angles. The initial step in this study is identifying concepts, theories, empirical research and models that support the understanding of the user-centred design of a students' time management analytics tool employing data sources outside a VLE.

In this stage, we discussed literature within several domains, such as time management analytics (data sources, ubiquitous technology, users' privacy), user-centric design, and

mobile application. The literature review was essential for two main reasons. First, to provide a knowledge foundation and identify research gaps on time management apps for students. Second, identifying data sources outside a VLE (e.g., browsing history, social network activity, tracker app) that may be related to users' sensitive information. The students' perception of time management apps using these data sources is not much explored yet. Therefore, in this study, we want to explore which data sources would be more helpful for supporting self-reflection according to students' opinion. We also asked students how they would like to reveal the information to others. The literature review around these concepts helped us as to how user-centric design that involves students in the mobile application development started from ideation to user experience evaluation.

Stage B. Requirements Analysis

The requirements analysis was divided into two phases: (1) an online questionnaire to get users' perception of the use ofdata sources outside a VLE and (2) student group discussions to gather user requirements for the selected data sources identified in the online questionnaire. User requirements were built using qualitative and quantitative data. Data collecting may use questionnaires, interviews, and focus groups to obtain participants' thoughts, attitudes, and perceptions regarding an existing or potential product (Ricci et al., 2019).

Stage B.1. *Online Questionnaire*

Questionnaires were chosen in this study to elicit user requirements and needs because they allow fast data collection and support broad generalization of results. Rotaru et al. (2020) claimed that surveys are often used in HCI to gather generalizable user needs and requirements for studying a phenomenon, establishing theory, or developing solutions. Questionnaires can also be used to evaluate product or design user experience.

In our study, we investigated multiple data sources which derive outside the VLE that potentially support students' time management analysis. All data sources outside a VLE are likely to contain personal information that the users absolutely own, and are not owned by an educational institution. Therefore, it is the students' privilege to record or reveal this information to others. In this study, we need to focus on which data sources are useful for students' self-reflection from their point of view. Moreover, we also need to consider how students perceive each data source, whether they feel the data is sensitive information or

not, and how they would like to reveal the data to others, including their personal tutor, the university, or their peers.

Stage B.2. *Focus Group Discussion*

Focus group discussions enable the collection of genuine and valuable user feedback and can provide in-depth knowledge of user tasks, their current context, challenges encountered, or present and future demands (Djafarova and Bowes, 2021). In our study, we use focus group discussions to get a deeper understanding of students' reasoning about the data sources chosen from the questionnaire results. We also explore how users would like to reveal information to others to get more understanding of users' privacy. Since the data sources involved in this study are those outside a VLE, the information is likely to be sensitive. Hence, the privacy issue might also be a potential risk that influences user acceptance of our mobile application. Therefore, it is necessary to know how users would like their data to be managed. This information is essential for the app development. In these group discussions, participants are also asked to draw a low-fidelity design on paper so that there are more ideas for UI and app development.

The discussions were audio-recorded and analysed using thematic analysis. In order to find significance and patterns, content is first transcribed, coded, and then thematically arranged using this qualitative analytical method (Creswell and Poth, 2016). Qualitative research methods may employs inductive or deductive analyses or the combination of both. Deductive coding is a top-down strategy which starts with a set of specified codes and then discovers snippets that match these codes. A bottom-up method called inductive coding makes it possible to begin with no codes and add them when evaluating the dataset. Before beginning to code, we should choose whether to start with a set of categories which represent the research question (deductive coding), come up with the codes that emerged from transcribed material (inductive coding), or take a combination approach. In our study, we have a set of questions to lead the discussions that represent what we wish to know. Therefore, the analysis of participants' feedback obtained in group discussions at this stage used deductive coding.

Braun and Clarke (2006) proposed the steps for obtaining the themes and further details were explained by Maguire and Delahunt (2017). There is a six-phase guide which is a constructive framework for conducting a thematic analysis. The phases themselves are not

necessarily sequential, they may be moved forward and back between them perhaps often, especially when dealing with a lot of data. The six-phases are:

Step 1. Data familiarity

Qualitative analysis begins with reading and rereading the transcripts. Making rough notes regarding initial thoughts relying on the extract is important at this stage. The researcher must grasp the interaction and all parts of the data. This stage prepares for the subsequent analysis.

Step 2. Identifying preliminary codes

In this phase, we organise the extract in a systematic and meaningful way. Coding divides the extract into smaller chunks of meaning. The code of each segment is supposed to be relevant to capture something interesting regarding the research questions. The coding process is open, which means there are predefined codes, but the codes may be developed and modified during the process. Furthermore, having two or more people working on the coding is helpful, but it is not mandatory (Maguire and Delahunt, 2017).

Step 3. Search for themes

Braun & Clarke (2006) explained that there are no hard and fast rules to define a theme, capturing important or exciting data regarding the research question. There are also possibilities of overlap between the coding stage and the theme searching process. The code itself may fit into one or more themes, and we might use a "miscellaneous" theme to manage the code at this point. This step's result is the organisation of codes into broader themes that have meaningful findings regarding the research question.

Step 4. Review themes

At this stage, themes that were found in the previous phase are reviewed. Gathering all the data that is relevant to each theme is helpful for reviewing or modifying the themes. If themes overlap, there should be a consideration of whether or not they are separate themes. The themes found in this phase should be coherent and should be distinct from each other. At this step, qualitative data analysis software can be helpful.

Step 5. Define themes

The themes from the previous step are refined and matched with the research questions. At this stage, the essence of what each theme is about is defined. The sub-themes then are also organised to their related main themes.

Step 6. Write up

The endpoint of qualitative research frameworks is the writing and analysis of all the codes and themes into a report. The themes obtained from this analysis served as the header of main outline which then were described and supported by relevant quotes from students.

In this stage, students were also asked to design app screen using papers and pencil. This paper-prototyping helped to visualize the design in the very early stages of design process (Miller, 2021). The participants' screen designs represent the expected features in the mobile app. The most expected features are then likely to be implemented.

Stage C. Design Concepts and Artifacts

In stage C, user requirements that were obtained from group discussion analysis, were translated into specific design concepts and artefacts. Concept development in user-centred design is an iterative process that involves reassessing and merging previous concepts, visualizing them, and testing them with users (Hornecker and Ciolfi, 2019). Low-fidelity designs by participants from the previous session (group discussions) help us to understand what participants' expectations about the features and user interface of the app. Mostly, the screen design ideas from participants represent expected features. Therefore, we need to design a good scenario from user input to data management, so the app implements the features expected by the participants.

During the design process of software applications, product mock-ups allow us as a designer to test our ideas and concepts (Durham and Kenyon, 2019). The screen designs from participants are then implemented in a high-fidelity design and are arranged into a prototype. Then, the interactive prototype is used as a follow-up (Stage D) to allow further understanding of user requirements.

Stage D. Usability Testing

Usability testing requires relevant users to perform representative activities with a prototype or final product in realistic settings (Bubrik et al., 2021). Usability tests are a crucial component of the user-centered design lifecycle since they aid in assessing fresh thoughts, ideas, and options (Maguire, 2019). The key advantage of this approach is that it enables an extensive and complete review of design artifacts, exposing user interface faults that could provide issues and obstacles for users while interacting with an interface (Bubrik et al., 2021).

There are several usability testing methods (Riihiaho, 2018) including:

- Moderated vs. unmoderated

  A moderated usability test is a test session which is managed by a researcher who describes the test to participants, answers participants' questions, and asks them follow-up queries (Khayyatkhoshnevis et al., 2022). In-depth results are typically obtained from moderated testing since there is direct communication between researchers and test subjects. Moderated testing, however, might be costly to plan and carry out (e.g., renting a lab, appointing a qualified researcher, and/or finding volunteers). Moderated testing usually results an investigation of the reasoning behind user behavior.

  An unmoderated test, on the other hand, is conducted independently. Participants may be in a lab, but it's more probable that they stay in their natural environment using their own gadgets to access the website or software application being tested. Without the moderator's presence, a participant may feel more comfortable expressing negative opinions about a system or service (Generosi et al., 2022). However, in unmoderated usability testing, the unavailability of a moderator may have an impact on the users' responses and may lead the participants' comments regarding the user experience to be less informative (Khayyatkhoshnevis et al., 2022).

  The presence of a moderator in the testing environment has benefits and drawbacks. Although the absence of the moderator reduces the likelihood of test data bias, the user may feel concerned and confused if in the testing environment alone, which could skew the results (Hertzum 2020). The possibility of influencing the test participants' conduct through the moderator's body language and tone expression is highlighted in the guidelines for engaging with test participants. However, there is little research on the

actual impact of the moderator's presence and absence, and what exists has yielded a range of outcomes (Riihiaho, 2018).

Considering the above-mentioned usability testing methods, this study adopts moderated test since it produces in-depth results which is essential in this early stage of app development. To avoid bias, the moderator performs low intervention when participants complete the tasks. Additionally, the interaction between researcher and participants can help participants when they face difficulties, e.g., technical problem when accessing the prototype.

- Remote vs. in person

  Remote tests can be carried out online or over the phone and are accessible remotely from any location. In-person tests are carried out in a test site or office, with a researcher there to monitor participants as they take the test. In-person assessments offer more data points than remote tests since researchers can actually observe participants and evaluate their nonverbal cues. However, since it requires a convenient site, scheduling a specific date, and recruiting (and compensating) volunteers, in-person testing is typically time-consuming and costly.

  Furthermore, in-person testing is preferable since direct observation to the participants can be done, includes gestures and facial expressions. However, since we faced a lockdown situation due to the Covid-19 pandemic when the tests were performed, remote tests were a solution for our usability testing. The test was done over the internet with students sharing their screens as they completed the task.

- Qualitative vs quantitative

  Quantitative data provide an indirect evaluation of a usability design, whereas qualitative data provide a direct evaluation of the usability of the system (Budiu, 2017). Researchers use qualitative usability testing to identify problematic design features by observing how users interact with particular UI elements. After gathering more information from participants, they can decide which UI components needs to be changed.

There are three widely used quantitative usability requirements (Jokela et al., 2006) as defined in ISO 9241-11:

- Effectiveness: a measure of the percentage of users who can perform a task successfully
- Efficiency: a measure of the average amount of time required to accomplish a task successfully.
- User Satisfaction: a measure of the satisfaction of users with the design.

Since quantitative indicators do not identify the issues users faced, they can be challenging to comprehend in the absence of a point of comparison. When the design process is still in its early stages, qualitative testing can be helpful because it will confirm whether the target users find the design concepts to be logical and appealing. Later, when a design is already being used, quantitative testing is required to monitor how potential changes may effect its usability (Karampelas, 2022). Therefore, this study used qualitative usability testing to gather more information about user perceptions and identify problematic or intriguing design elements.

In this study, participants were asked to verbalize their thoughts when completing the tasks set and interacting with the prototype. This technique is often referred to as a think-aloud protocol (Fan et al., 2020). Rankine (2019) explains that thinking aloud is an interviewing technique in which participants verbalize their thought processes while reviewing transcription data for better analysis and comprehension of the information. Using open-ended questions, the thinking aloud approach identified a common method, meanings, and material from each session. Thinking-aloud is also a useful technique for discovering user experience since it provides designers with authentic and applicable input in the design environment (Johanssen et al., 2019).

The participants in our study may evaluate the interactive prototype from several aspects, such as task scenario, navigation and UI interfaces. Throughout completing several tasks given, participants used the Thinking Aloud Protocol (TAP) to contribute qualitative feedback. The qualitative data obtained at this stage is analysed further using inductive thematic analysis to identify usability concerns which were summarised as design considerations.

Stage E. User Experience Evaluation

The last step in this study is to get the User Experience (UX) evaluation from users in a natural environment. This testing does not scale in terms of the number of testers or long-term observations. The principal advantage of this strategy is that field research may disclose how individuals engage with natural surroundings (Lindbloom et al., 2020). Konstantakis and Caridakis (2020) reported that evaluation in a field setting provides a more realistic context to obtain more reliable user experience data. Users' perceived value and satisfaction are critical factors for accepting and engaging with the app (Vahdat et al., 2021). In our study, users were asked to install our mobile application on their smartphone. Therefore, the participants could interact directly with the application and evaluate how the app may help them do self-reflection.

The concept of user experience is typically thought of as being multidimensional (Boy, 2017). For instance, a product should meet extra criteria like aesthetics, joy of use, novelty, or beauty in addition to being simple to learn how to use, efficient to use, or properly controlled. According to Nakamura et al. (2020), the first group of criteria is sometimes referred to as pragmatic quality aspects, whilst the second category is known as hedonic quality elements. ISO 9241-210 (ISO, 2010) defines user experience as a person's responses and emotions as a result when they use a product, system, or service. As a result, user experience is seen as a broad concept that incorporates all kinds of emotional, intellectual, and physiological responses associated with the actual or even presumed use of a product. There are UX questionnaires that measure user experience by considering those comprehensive aspects before, during and after use of application.

Stage F.1. *User Experience Questionnaire (UEQ)*

There are several user experience research frameworks in the market, for example: Questionnaire for User Interaction Satisfaction (QUIS[6]), the Standardized User Experience Percentile Rank Questionnaire (SUPR-Q)[7], and User Experience Questionnaire (UEQ)[8]. Each of the UX questionnaires measures different aspects of quality characteristics. Standardized questionnaires are not just a collection of arbitrary questions; they are the product of a thorough creation process. This procedure ensures precise measurement of the

[6] http://lap.umd.edu/quis/
[7] http://www.suprq.com/
[8] https://www.ueq-online.org

desired UX attributes. QUIS is a proprietary framework also good for delivering general usability. Furthermore, QUIS provides detailed validation support, so the UX researchers can accurately validate the questionnaire results. SUPR-Q is a more specific framework used for evaluating websites. Moreover, SUPR-Q also provides a list of other websites' scores so that UX researchers can compare their score.

Compared to these four frameworks, UEQ provides a more comprehensive user experience analysis (Julian et al., 2021). It enables users to convey sentiments, impressions, and attitudes that come from experiencing the investigated product in a straightforward and timely manner. In addition, UEQ provides a free analytical tool for precisely interpreting the results. This study adopts UEQ with 26 items to assess user experience (Schrepp et al., 2015). The participants were asked to use the application for a specific period, so they have the experience to interact with the app. Participants were also asked to complete several tasks given. At the end of the user-trial period, the participants filled out the UEQ to assess their overall experience regarding the tested technology.

Stage F.2. Open Ended Questions

This study adopts an open-ended questionnaire to complement the findings from UEQ. The app testing is in the real world and takes a specific period so the participants can figure out how the app may support their self-reflection. During the testing, the participants make notes regarding their experience and problems that arise. These notes will help them to support the retrospective questionnaire. The note taking method gives better results than just retrospection because the action helps the participants remember thoughts, not just reconstruct them (Matthies and Dobrigkeit, 2021).

3.3 Ethical Considerations

The research projects were approved by SagE Faculty Ethics Committee from 01/05/2018 – 31/10/2019 with , the Ethical Approval being extended until 31/10/2023. The Ethics Approval is attached in Appendix A.

All participants were provided with verbal and written information about the projects and the confidential management of the data obtained. Each participant signed an informed consent form, and participation was entirely voluntary. Participants were advised that they

might withdraw without explanation at any moment. In such a scenario, their information would be removed and deleted. Only members of the study team have access to the encrypt computers containing the collected research data.

3.4 Declaration of Conflicting Interests

The doctoral candidate affirms that there was no conflict of interest with any of the participants, organizations, or publishers associated with this dissertation.

3.5 Reflections on Mixed-method methodology

One of the advantages of usinga mixed-method approach in the study s the user-centric design process of students' time management analytics was the opportunity to collect rich and broad research data. Throughout the many phases of technology development, qualitative approaches allowed participants to share their experiences and opinions regarding user demands, system functionality, and user interface, giving us with essential insights. The extensive time required for transcription and coding was a disadvantage of collecting and interpreting complex data. The transcription facilitated a better understanding of the gathered study materials. An argument against qualitative methods is that data and analysis are subjective. For a less subjective outcome, qualitative findings were validated with quantitative data and discussed with research advisors.

Qualitative methods yielded deeper insights for app development with a smaller sample than quantitative ones. To triangulate qualitative data, user experience data was collected quantitatively after user evaluations. The benefit was statistically analyzed questionnaires filled out by individuals. Quantitative and qualitative methods yielded detailed results on the entire UCD process, including personal reactions and statements, numbers, and statistics. A limited sample size is a limitation of the qualitative method, which affects the generalizability of the findings. In usability studies, data may not be statistically significant but are highly meaningful when qualitatively identifying UI issues that effect the user experience.

Chapter 4. Students' Perception on Various Data Sources for Self-Reflection on Time Management

This chapter describes the second stage of this study that is requirements analysis. Many data sources are considered to be helpful for students' time management. Those data sources need to be investigated and selected for further investigation to make this study more focused. The chapter is organised as follows: the discussion of data sources based on literature that might be helpful for students' time management application, questionnaire, data analysis and discussions.

4.1. Data Sources for Students' Time Management

In this study, we look at data sources outside of the VLE that may be useful for students' self-reflection on Time Management. As indicated in Chapter 2, this study investigates five categories of data sources.

The explanations for each category and the questions used in this questionnaire are provided below.

1. Library Access and Loan

It has been demonstrated that students' interaction with library services improves their engagement, motivation, and academic success (Sakeerudeen and Sanni, 2017; Zhao et al., 2020). Students' reasons for using the various library resources and services have been the subject of several studies on academic library users. The students' main reason to visit library are accessing learning space for individual and collaborative study (Hall & Kapa, 2015), print collections (Rose-Wiles et al., 2020), inter-library loan services (Alokluk, 2020), and use some library services, such as library printers, photocopying machines, digital board/projectors, and scanners (Oyovwe-Tinuoye, 2020).

According to Scoulas and De Groote (2019), there is a positive correlation between students' GPA and the use of library resources, both digital and traditional. Similar findings were made by Silwattananusarn and Kulkanjanapiban (2020), who discovered that a significant proportion of students with better GPAs have higher library check-out behavior. In terms of library use, Scoulas (2021) discovered that STEM students with poorer GPAs

were those who never used the library (online use, journals, databases, print books, subject and course guides) aside from in-person visits and textbooks. In terms of online users, Scoulas (2021) reported that both STEM and non-STEM respondents who usedthe online library had higher GPAs than those who never used it. In addition, Tokan and Imakulata (2019) reported that library visiting is an indicator of students' intrinsic motivation, which has a direct impact on their learning behaviour and achievement.

According to the literature above, students' access to a library, either physical or digital, may be a useful information for their self-reflection in a time management app. Therefore, we have included the following question for our questionnaire:

- Frequency of book loans from the campus library in a certain period
- Frequency of login to online campus library in a certain period
- Time spent accessing the online campus library in a certain period
- Time spent visiting the campus library
- Frequency of visiting the campus library in a certain period
- Date and time of campus library visits

2. Class Attendance

Class attendance is a significant predictor for students' persistence and results, and absenteeism increases dropout risk (Pinter et al., 2020). According to some experimental studies, class attendance is negatively correlated with students' academic performance (Zhu et al., 2019; Sekiwu et al., 2020). Therefore, we investigated students' views on how class attendance helps them self-evaluate their time management.

Information about class attendance may be obtained from RFID tags or face recognition apps. In their study, Akbar et al. (2018) built a student attendance monitoring system using RFID cards which recorded their arrival time. Only if the students were authenticated for arrival, could the students swipe their cards to record their leaving time. Agarwal et al. (2019) proposed a platform to monitor students' attendance that employed an intelligent system in classrooms. They integrated RFID technology, face detection mechanisms and location based service using students' registered smartphones to provide a robust platform for students attendance monitoring system.

In this study, we investigated students' views on their class attendance information in terms of usefulness level and privacy aspect. Based on the literature above, here is some information that may be obtained from the Class Attendance category:

- Date and time of arriving at lectures
- Date and time of leaving from lectures
- Class attendance over a certain period

3. Web Browsing History

The Internet plays a significant role in people's daily life in the digital era with its affordances. For example, people rely on the Internet for various purposes, such as learning, information searching, socialising, and entertaining (Apuke and Omar, 2021). Despite the many positive aspects of the Internet, the lack of a clear boundary between learning and entertainment frequently leads to media-related attention problems, such as taking a long time to complete a learning task because of social entertainment distractions and the temptation to multitask.

Nowadays, more people are aware of the benefits of time tracking software since it helps them and their business be more productive. Some commercial time tracking apps, such as Qbserve[9], RescueTime[10], and Timing[11], work by automatically tracking user activities, such as the time spent on accessing specific website addresses. These apps focus on reporting user activities in a certain period to help users become more productive. Indeed, these apps may be beneficial to support students' time management, but studies about the use of automatic time-tracking apps for students are not yet common. Therefore, we were interested in exploring automatic time-tracking apps for students in this research.

It is assumed in this study that knowing the time spent on each online activity from students' browsing log history will be beneficial to their self-evaluation of how they manage their time. Using this information, students may analyse whether the time proportion of their online activities is about right or needs to be adjusted. Furthermore, students may use this information to think of practical plans for improving their academic

[9] https://qotoqot.com/qbserve/
[10] https://www.rescuetime.com/
[11] https://timingapp.com/

performance to maintain a balance between leisure, information exchange, and academic performance.

Furthermore, RescueTime, a desktop and mobile app, is a popular app that tracks and analyzes how users spend their time on apps and websites. Because RescueTime uses passive measurement, no manual entry, picky timers, or start/stop buttons are required. Through device tracking, RescueTime divides the time spent on each online activity into categories and subcategories. This categorization is used in our research since it is relevant with this study about web-browsing history.

In the Rescue Time app there are several pre-existing categories of activities that can be tracked. The categories and sub-categories are listed below.

1. Categories News and Opinion have sub-categories: General, Business, Entertainment, Society, Science and Technology, Sports, Regional, International, Communications, Meetings
2. Categories Communication and Scheduling have sub-categories: General, Calendars, Email, Instant Message, Meetings, Voice Chat, Communications
3. Categories Reference and Learning have sub-categories: General, Business & Finance, Employment, Food, Health & Medicine, Home & Garden, Legal & Gov't, Maps & Regional, Engineering & Technology, Search, Travel & Outdoors, Communications, Meetings.
4. Categories News & Opinion have sub-categories: General, Business, Entertainment, Society, Science & Technology, Sports, Regional, International, Communications, Meetings
5. Categories Utilities have sub-categories: General, Anti-Virus & Spyware, Browsers, Internet Utilities, File Sharing, Virtualization, Other, Communications, Meetings
6. Categories Shopping have sub-categories: General, Office, Electronics, Clothes & Personal, Communications, Meetings
7. Categories Entertainment have sub-categories: General , Comedy, Games, Music, Photos, Communications, Meetings
8. Categories Social Networking have sub-categories: General, Professional Networking, Communications, Meetings

We include the categories of activity in the Rescue Time app in our questionnaire because they are relevant to the data explored in this study, specifically category Web Browsing History. These are the questions in this category:

- Time spent accessing Entertainment websites in a certain period
- Time spent accessing Communication/Scheduling websites in a certain period
- Time spent accessing Reference/Learning websites in a certain period
- Time spent accessing Social Networking websites in a certain period
- Time spent accessing News/Opinion websites in a certain period
- Time spent accessing Design/Composition websites in a certain period
- Time spent accessing Shopping websites in a certain period
- Time spent accessing Utilities (e.g., antivirus, internet utilities) websites in a certain period

4. Self-declared and tracker-app data

Smartphones we use today are sophisticated machines capable of working as personal assistants that can monitor our heartbeat, track our movements and locations. They often come with a built-in sensor, such as accelerometer, gyroscope, magnetometer, GPS, proximity sensor, ambient light sensor, fingerprint sensor, pedometer, barometer, heart rate sensor, thermometer, air humidity sensor, etc. Those sensors provide great help to track humans' activity, such as jogging, heart rate history, step counting and saving this activity history from time to time.

Students' physical and cognitive health are strongly influenced by physical activity (Pope et al., 2019). According to Calestine et al. (2017), cardiovascular endurance was inversely associated with study time, but hip flexibility and sedentary behavior were positively associated. Their study demonstrates a considerable drop in young adults' participation in physical exercise and an increase in sedentary behavior over the college years. However, Broaddus et al. (2021) reported that there are positive and significant correlations between step counts (obtained from the Fitbit tracker app), students' health lifestyles (self-reported through questionnaires), and academic performance for first-year college students at Oral Robert University in the United States. Their research shows that students' general activity and movement (measured by Steps and FatBurn) has the strongest link to GPA compared to the quantity of weekly deliberate exercise (measured by Cardio and Peak minutes). These

findings highlight the importance for students of maintaining a physically active and healthy lifestyle when they study in the university. Furthermore, psychological stress is a significant issue for university students and can have a detrimental affect on both their physical and mental health. It has been demonstrated that using exercise as a stress-management approach has a significant impact on both avoiding and treating psychological stress (Elliot et al., 2021).

Other data sources that might be useful for students' self-reflection regarding their time management is transportation time. According to Alfadley et al. (2020), students' transportation time and their time management skill significantly impact on students' class attendance. Travel times can vary depending on factors like city road plans, the availability of public transportation, and the distance between their home and their university location. According to a research conducted at the University of California-Davis School of Medicine, 24% of second-year medical students mentioned that travel time as a significant reason for absences from class (Eisen et al., 2015). Alamoudi et al., (2021) carried out investigation on the relationship between students' travel time and their class attendance. Most of their participants need 30 - 60 mins to reach the university which significantly impacted on the class attendance punctuality and absence.

However, not all activities can be tracked by these built in/hardware sensors, particularly for capturing user experiences that cannot be directly measured (such as feelings, ideas). To record users' experience, such as what they do at a specific times, we need them to declare their activity and what they feel about using the software. Furthermore, such a combination of hardware and software sensors tracking location, date, and time can be implemented by using both built-in smartphone sensors and students self-declared activity. With the aid of this combination, students will be able to trace their movements and get a full picture of what they did, just like in a personal diary.

The literature mentioned above suggests that the combination of tracker data and self-declared information may be a beneficial tool for students' self-reflection in a time management software, enabling them to identify their behavior by looking at their timeline activities. Therefore, we have incorporated the following query into our survey:

– Date, time, and location of my study logs

- Date, time, and location of my exercise logs
- Date, time, and location of my work logs
- Date, time, and location of my entertainment logs
- Date, time, and location of my transport logs
- My activities duration report in a certain period
- Sleep logs
- Heart rate logs
- Body weight logs

5. Social network activities data

Online social networks (OSNs) are becoming a prominent communications tool, particularly in the student community. Considering the advantages and disadvantages of online social networks, it seems that data collection from students' social media has a high potential for assisting their self-reflection in time management. A previous study by Kitto et al. (2015) has implemented the Connected Learning Analytics Toolkit (CLA Toolkit) to improve student engagement and learning in collaborative online environments. This tool incorporates and analyses data from social media platforms that most students already use in their personal lives and increasingly use in education. The social media platforms investigated in Kitto's study are Facebook, YouTube, Google+, Google Docs, Twitter, WordPress, and StackExchange. Kitto et al. (2016) reported that the toolkit could be accessed by anyone in a trial account at: http://clatoolkit.beyondlms.org/ with username: trialAccount, password: tryoutCLAtoolkit. This research by Kitto et al. (2016) reinforced the possibility of bringing social media platforms into Learning Analytics research. However, this study paid no attention to students' willingness to share their social media account with others.

Facebook, Whatsapp, Twitter, Instagram, Snapchat, Youtube, and Google are the most well-known and widely used social media platforms (SMSs) in the Western world (Alexa, 2017). Kircaburun et al. (2020) conducted a survey in 2018 examining the usage social media site, such as Instagram, Youtube, Facebook, Google+, and Twitter among Turkish university students. They found that Instagram, Youtube and Facebook were the most used social media platforms amongst the participants. According to a survey carried out by Smith and Anderson (2018), the majority of US adults used Facebook and YouTube. A

greater variety of websites was also used by younger Americans (18 to 24 years old), with Snapchat, Instagram, and Twitter being the most popular ones among them after Facebook and Youtube.

This questionnaire was distributed in the early 2018. Considering the variety of social networking sites available in 2018 as noted in the literature, we used the following questions in our questionnaire:

- Time spent accessing Facebook in a certain period
- Time spent accessing YouTube in a certain period
- Time spent accessing Twitter in a certain period
- Time spent accessing Blogging in a certain period
- Time spent accessing Help websites (e.g., Stackoverflow) in a certain period

4.2. Questionnaire Instrument

The questionnaire used in this study comprised 32 questions in five categories that measure the usefulness, sensitivity and the students' willingness to share various data sources with their tutor, university or peers. Respondents evaluated each item on the usefulness and sensitivity level based on a Likert scale ranging from 1 (not useful/sensitive at all) to 4 (very much useful/sensitive).

There is a controversy in Likert data format which is the debate about the midpoint in Likert option. According to the original research by Likert (1932) original research, symmetrical responses with a neutral center are typical for response formats. He suggested a five point response format with a midpoint in his work. However, Likert did not base this decision in theory and rather suggested that variations on this five-point format may be appropriate (Schrum et al., 2020). The goal of the Likert scale was to avoid pressuring respondents into expressing agreement or disagreement when they might not have such a firm opinion or depth of information on the subject.

However, we use Likert without a midpoint in our study. According to Murat (2022), this option is also valid since a mid-point response may encourage undue ambivalence which has an impact on the credibility of the data. A neutral midpoint may result in users choosing the option that may not be the most accurate to avoid extra cognitive strain resulting in an

over-representation at the midpoint (Schrum et al., 2022). The underlying reason why respondents choose mid-point values might be interpreted in a variety of ways. According to Willits et al. (2016), it could imply that the respondent: (1) has no opinion; (2) has a "balanced" view in terms of evaluation; (3) is indifferent/does not care; and/or (4) does not understand the question.

A pilot study before the questionnaire was launched was conducted to evaluate content validity, check whether the time range to complete the questionnaire was met and if the questions could be understood from the participants' point of view. The first round of the pilot study aimed to evaluate the content validity with critical appraisals of the questionnaire by the team of two advisors. On this basis, no new items were inserted, and 3 items were deleted, which were: body weight, heart rate, and sleep logs. The second round aimed to assess whether the questionnaire could be done within the suggested time and that the participants properly understand the terms used in the questionnaire. There were ten student participants that joined voluntarily in this second round of the pilot study which are excluded from the main survey. From the questionnaire simulation in the second round, there were some suggestions from students:

1. To add more information about similar products that can inspire participants about the scope of this research in a 5-min presentation before completing the survey.
2. Change the term 'student cohorts' into 'peers' so the terms can be understood more easily.

There are ten questions in our questionnaire, with some questions contain sub-questions. The detailed list of questions in our questionnaire is shown in Table 4.1.

No	Question	Answer
1	Students of School:	
2	Programme / Stage	
3	Please rate your level of awareness regarding the importance of self-reflection during your study	1 = Unaware 2 = Less aware 3 = Aware 4 = Very aware

4	Please indicate your level of familiarity with quantified self-technologies, e.g. Fitbit tracker, Strava and RescueTime	1: No experience 4: High level of experience
5	Please select your mobile operating system preference	IOS Android Both mobile OS
6	**Library Access and Loan**	
6.1.	*Frequency of my book loan from the campus library in a certain period*	
6.1.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
6.1.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.1.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.1.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
6.1.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
6.2.	*Frequency of login to online campus library in a certain period*	
6.2.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
6.2.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.2.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.2.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all

6.2.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
6.3.	*Time spent accessing the online campus library in a certain period*	
6.3.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
6.3.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.3.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.3.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
6.3.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
6.4.	*Time spent visiting the campus library*	
6.4.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
6.4.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.4.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.4.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
6.4.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
6.5.	*Frequency of visiting the campus library in a certain period*	
6.5.a.	Is this information useful?	- Not useful at all - Less useful

		- Useful - Very useful
6.5.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.5.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.5.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
6.5.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
6.6.	*Date and time of campus library visits*	
6.6.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
6.6.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
6.6.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
6.6.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
6.6.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
7	**Class Attendance**	
7.1.	*Date and time of arriving at lectures*	
7.1.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
7.1.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive

7.1.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
7.1.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
7.1e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
7.2.	*Date and time of leaving from lectures*	
7.2.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
7.2.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
7.2.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
7.2.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
7.2.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
7.3.	*Class attendance report in a certain period*	
7.3.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
7.3.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
7.3.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
7.3.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data

		- Not share at all
7.3.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8	**Web Browsing History**	
8.1.	*Time spent accessing Entertainment websites in a certain period*	
8.1.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.1.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.1.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.1.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.1.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.2.	*Time spent accessing Communication/Scheduling websites in a certain period*	
8.2.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.2.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.2.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.2.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.2.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all

8.3.	*Time spent accessing Reference/Learning websites in a certain period*	
8.3.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.3.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.3.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.3.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.3.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.4.	*Time spent accessing Social Networking websites in a certain period*	
8.4.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.4.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.4.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.4.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.4.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.5.	*Time spent accessing News/Opinion websites in a certain period*	
8.5.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.5.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive

8.5.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.5.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.5.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.6.	*Time spent accessing Design/Composition websites in a certain period*	
8.6.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.6.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.6.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.6.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.6.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.7.	*Time spent accessing Shopping websites in a certain period*	
8.7.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.7.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.7.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.7.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data

		- Not share at all
8.7.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
8.8.	*Time spent accessing Utilities (e.g., antivirus, internet utilities) websites in a certain period*	
8.8.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
8.8.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
8.8.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
8.8.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
8.8.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
9.	**Self Declared and tracker-app data**	
9.1.	*Date, time, and location of my study logs*	
9.1.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.1.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
9.1.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
9.1.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.1.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data

		- Not share at all
9.2	*Date, time, and location of my exercise logs*	
9.2.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.2.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
9.2.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
9.2.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.2.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
9.3.	*Date, time, and location of my work logs*	
9.3.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.3.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
9.3.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
9.3.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.3.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
9.4.	*Date, time, and location of my entertainment logs*	
9.4.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.4.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive

		- Sensitive - Very sensitive
9.4.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
9.4.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.4.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
9.5.	*Date, time, and location of my transport logs*	
9.5.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.5.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
9.5.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
9.5.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.5.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
9.6.	*My activities duration report in a certain period*	
9.6.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
9.6.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
9.6.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all

9.6.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
9.6.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
10.	**Social Network Activity**	
10.1.	*Time spent accessing Facebook in a certain period*	
10.1.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
10.1.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
10.1.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
10.1.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
10.1.e	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
10.2	*Time spent accessing YouTube in a certain period*	
10.2.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
10.2.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
10.2.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
10.2.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all

10.2.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
10.3.	*Time spent accessing Twitter in a certain period*	
10.3.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
10.3.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
10.3.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
10.3.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
10.3.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
10.4.	*Time spent accessing Blogging in a certain period*	
10.4.a.	Is this information useful?	- Not useful at all - Less useful - Useful - Very useful
10.4.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
10.4.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
10.4.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
10.4.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all
10.5.	*Time spent accessing Help websites (e.g., Stackoverflow) in a certain period*	
10.5.a.	Is this information useful?	- Not useful at all - Less useful

		- Useful - Very useful
10.5.b.	Is this data sensitive?	- Not sensitive at all - Less sensitive - Sensitive - Very sensitive
10.5.c.	I'd like to share this information with my personal tutor	- Share as identifiable data - Share as anonymous data - Not share at all
10.5.d.	I'd like to share this information with the university	- Share as identifiable data - Share as anonymous data - Not share at all
10.5.e.	I'd like to share this information with my peers	- Share as identifiable data - Share as anonymous data - Not share at all

Table 4.1. List of questions in our questionnaire

4.2.1. Data Analysis Technique

Since our data types are ordinal and nominal, both are categorical; our analysis method should comply with categorical data. Below is the explanation of the data analysis techniques used to investigate the questionnaire results.

1. Ordinal data analysis

Previous studies have found that ordinal data are often presented or analysed in ways that do not follow the data structure (South et al., 2022; Alabi and Jelili, 2022). This incorrect presentation and wrong data analysis may lead to bias and misleading information. The example of unacceptable use of ordinal scales was that the Likert data with ordinal scales were often summarised, and a mean value (with accompanying standard deviation) was computed. Hence, the scale was treated as an interval/ratio scale (South et al., 2022). This type of data manipulation is widespread but is not a correct way to handle ordinal data. The interval and ratio data are only numeric if they are initially numeric values, and re-coding of ordinal data into numeric does not give numeric variables.

Depending on how the Likert item was created, the measures provided by Likert scales might be viewed as ordinal (i.e., discrete) or interval (i.e., continuous) in nature (South et

al., 2022). The approach researchers use to summarize and run statistical tests on Likert data is influenced by whether the data is interpreted as ordinal or interval. When Likert data is assumed to be ordinal data, it is best to use descriptive statistics that do not require any more information beyond the relative ranking of the response alternatives, such as: mode, median, inter-quartile range (Russel and Kumar, 2022). Consequently, the visual representation of Likert data in an ordinalist interpretation should highlight the discreteness of the data, such as a histogram or stacked bar chart (South et al., 2022). Since no assumptions are made regarding the normality or continuity of the data, non-parametric statistical tests are suitable to summarize ordinal Likert data (Arvidsson, 2019).

On the other hand, interpreting Likert data as an interval scale provides for a broader variety of descriptive statistics. The arithmetic mean and standard deviation are particularly acceptable for data summary when equal distances between each response option are assumed (Alabi and Jelili, 2022). When summing up data from a Likert interval scale, it has been demonstrated that the mean rather than the median is a superior indicator of central tendency (Murat, 2022). Under an intervalist interpretation, visualization techniques that treat Likert data as continuous are suitable, such as bar charts of means or violin plots of densities. Statistical parametric tests may be appropriate if no other violations of test assumptions exist under the intervalist approach (South et al., 2022).

Our study collects data to get students' perceptions of how useful each data source used in our questionnaire may support their self-reflection. The score range is from 1 to 4, which represents not useful at all, less useful, useful and very useful. We also collect data to measure students' perceptions regarding each data source's sensitivity level. The score range from 1 to 4, which represent not sensitive at all, less sensitive, sensitive and very sensitive. We consider the Likert data type in our study as ordinal since the values are discrete and have no consistent spacing between each 'scale step'.

Thus, to analyse the usefulness and sensitivity of each data item used in our questionnaire, we used the mode and frequencies to measure the central tendency of students' perceptions. We grouped the participants based on their degree level to enrich the analysis. Doing so make us able to distinguish students' perception tendency between undergraduate, masters and PhD students.

2. Nominal Data Analysis

The nominal data type can be categorised, and can be qualitative and quantitative (Golfarelli and Rizzi, 2020). Various types of qualitative data can be represented in nominal form, e.g., gender, colours, letters, blood type and marital status. The quantitative of nominal data cannot be treated using mathematical operators (e.g., identification number). We can perform almost any value operation as long as we do not combine or confuse identities. Thus, the only measure of central tendency for such a data type is the mode, which has a purely qualitative interpretation (Chakrabarty, 2021).

Similarly, Mishra et al. (2019) suggested using non-parametric statistical methods to analyse nominal, ordinal and discrete data. By this reasoning, analyse of nominal data, for example, should be limited to summary statistics such as the number of cases, mode, and contingency correlation to preserve their identity. As an alternative, nominal data also can be analysed using the grouping method. The variables can be grouped into categories, and for each class, the frequency or percentage can be calculated. The data can also be presented visually using a pie or bar chart (Golfarelli and Rizzi, 2020).

In our study, we asked questions to assess respondents' willingness on how they would like to share their data. There are three available responses to answer these questions: *share as identifiable data, share as anonymous data*, and *not share at all*. Each participant must answer all of the questions since they cannot leave a single answer blank. Moreover, participants in this study also need to answer using one option only, e.g. they cannot answer the question by choosing *share as identifiable data* and *share as anonymous data* for the same question. There is also no hierarchy between the categories, i.e. there is no numerical difference between categories. These response choices are considered as both exhaustive (i.e., all potential responses are listed) and mutually exclusive (i.e., no overlap in choices) (Lee and Chen, 2018).

Although the nominal data lack a numerical value or relationship, they still can be analysed using advanced statistical methods. We may use non-parametric tests such as the chi-squared test to test the hypothesis for this data type. The chi-squared test aims to know whether there is a significant difference between the expected and the observed frequency of the given values (Taheerdoost, 2022). However, we employ the mode to analyse our

nominal data based on students' degree levels to answer our first research question. In this study, the usage of descriptive statistics is sufficient to answer our first research question, i.e. to get students' views on data privacy and how they want to disclose the data from different sources outside VLE for their time management app.

4.3. Data Analysis

4.3.1. Sample and Design

Due to the nature of this project, the students at Newcastle University who participated in this study were recruited using a convenience sample. The recruitment process was by contacting the participants via emails, students' society social media and posters. Furthermore, this research has been approved by the Research Ethics Committee at the Science, Agricultural and Engineering Faculty, Newcastle University. Appendix A contains the ethical approval that was obtained.

The survey was conducted from January to February 2018, 79 university students voluntarily and anonymously participated. Master students made up the vast majority. Figure 1 below shows the proportion of participants' degrees.

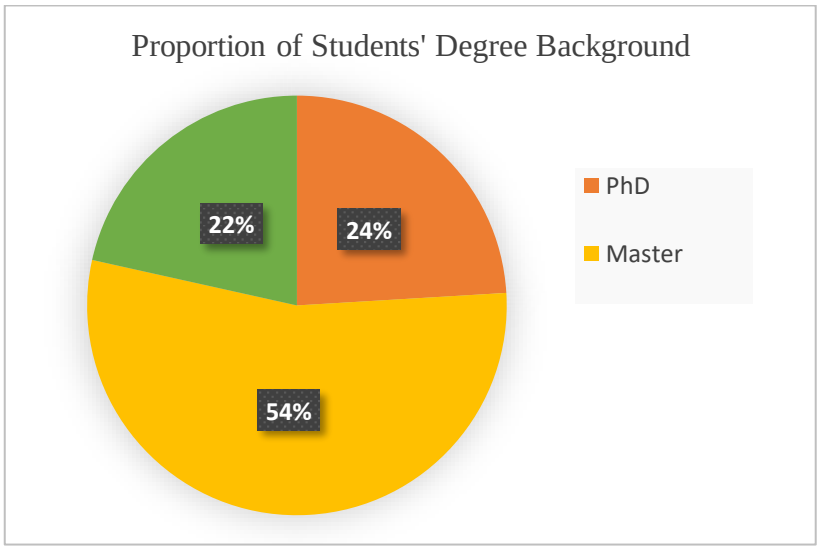


Figure 4.1. The proportion of participant's degree

In our main survey, furthermore, students were asked to watch the 5-mins presentation before completing the questionnaire. Once they completed the survey with a valid response, they got a shopping voucher as a reward. From this questionnaire, a list of which data were

most useful and sensitive based on students' perceptions was obtained. We also get a picture of how students would like to share their data with their personal tutor, university or peers.

In our analysis, the results for each degree level (PhD, Masters, and Undergraduate) were investigated so as to know whether different students' cohorts may have specific behaviours. Descriptive statistics were used to describe the students' perceptions. Based on the explanation above, the data types used in our study are ordinal and nominal data. Therefore, visualisation techniques were used to explain the central tendency of students' perceptions.

4.3.2. Questionnaire analysis of Undergraduate student respondents

In this research, we asked students to rate the level of usefulness of each data source using an integer range from 1 to 4, which represent not useful at all, less useful, useful and very much useful. We also asked students to rate the level of sensitivity of each information using an integer range from 1 to 4, which indicate not sensitive at all, less sensitive, sensitive and very sensitive. We received 17 out of 79 responses from Undergraduate students. The subjects of these 17 students are illustrated as follows (Table 4.2).

School	**Stage**	**Mobile Phone OS familiarity**	**Frequency**
School of Computing	2	Android	2
	2	IOS	1
School of Natural and Environmental Sciences	2	Android	2
	4	IOS	1
School of Engineering	3	IOS	2
Business School	1	Both mobile operating system	1
	3	IOS	1
		Both mobile operating system	1
School of Engineering	1	Both mobile operating system	1
	3	Android	1

		Both mobile operating system	1
School of Biomedical Sciences	2	IOS	1
School of Medical Education	3	IOS	1
School of Humanities and Social Science	1	Android	1
School of Arts and Cultures	2	Android	1

Table 4.2 Subject, level and mobile phone OS familiarity of undergraduate student participants

Figure 4.2 below reveals the Undergraduate students' preference regarding the usefulness level of each data source in our survey result.

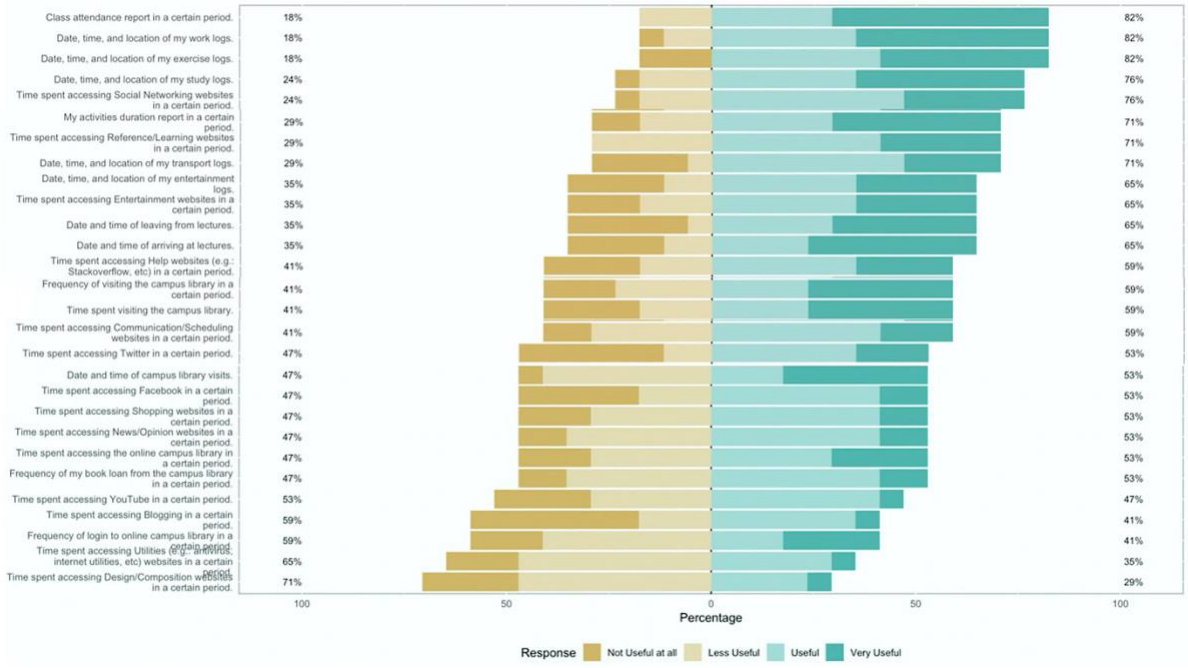


Figure 4.2. Usefulness level each data sources from Undergraduate students' response

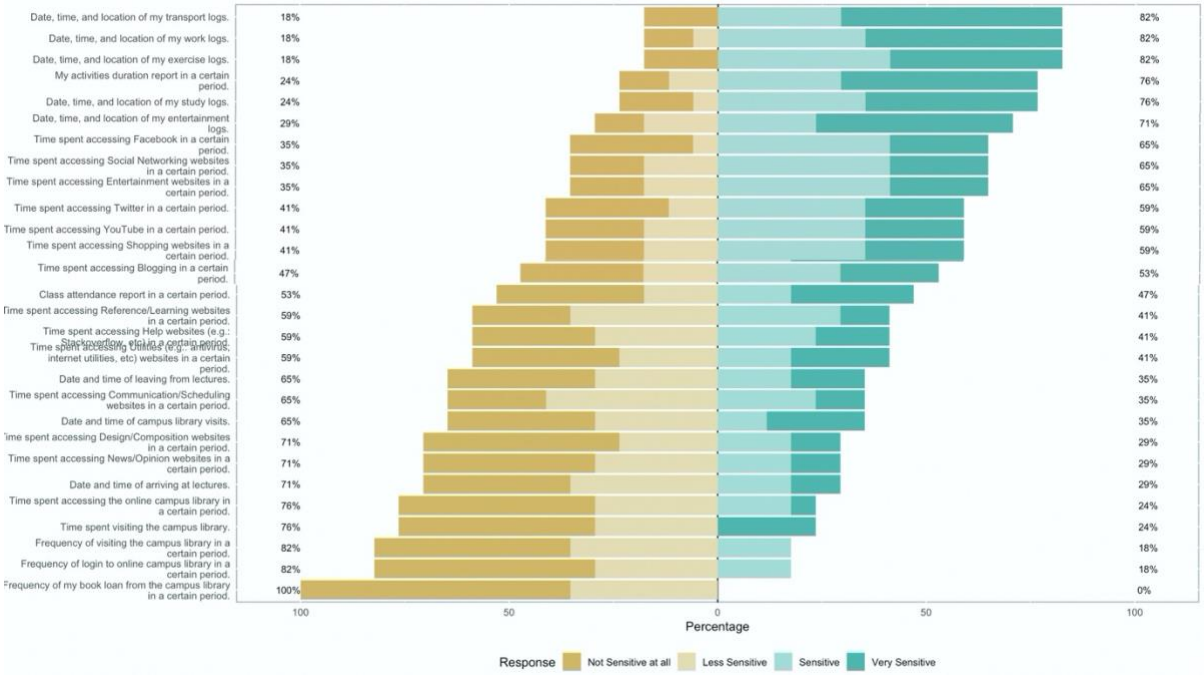


Figure 4.3. The sensitivity level of each data source from Undergraduate students' response

In Figure 4.2, we may see the top-five most useful data sources according to Undergraduate students' answers are:

- Class attendance report in a certain period
- Date, time and location of work logs
- Date, time and location of exercise logs
- Date, time and location of study logs
- Time spent accessing social networking websites in a certain period

Based on the list above, the most useful data sources from undergraduate students' responses are within three categories: class attendance, self-declared and tracker-app, and web browsing history.

From Figure 4.3, we see that according to Undergraduate students' responses, the most sensitive data sources are from the *Self-declared and tracker-app* categories. Furthermore, the less sensitive data sources are from the *Library access and loan* category.

This research also explored students' willingness to share information about each data source. Undergraduate responses regarding their desire to share the information with others will be discussed below, one by one for each category.

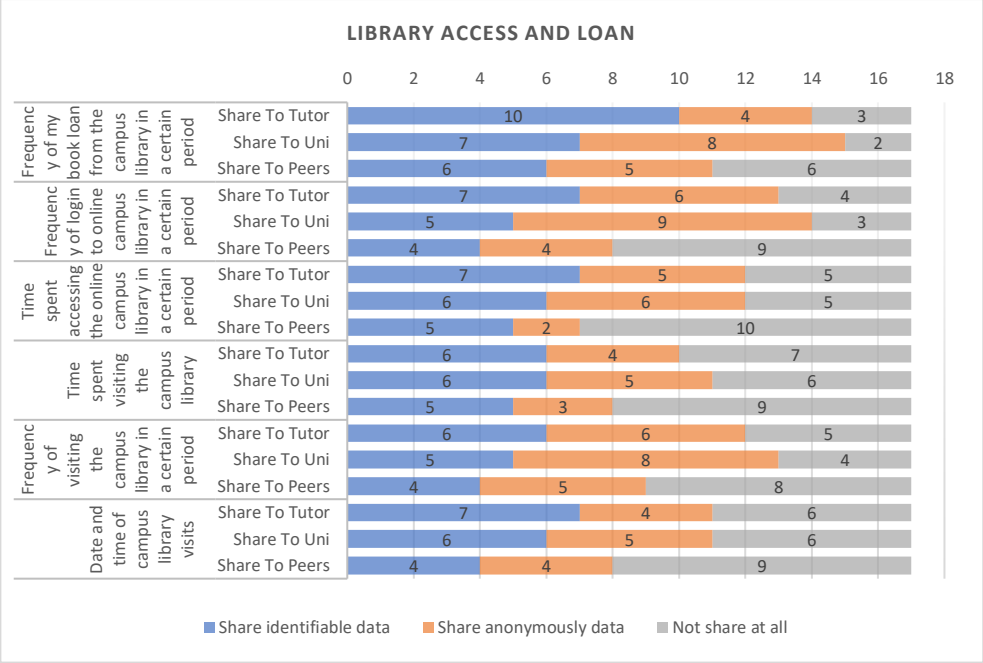


Figure 4.4. Undergraduate students' willingness to share Library Access and Loan data

As shown in Figure 4.4, students tend to share their library activities information identifiably with the tutor and anonymously with the university. Since students tend to share information identifiably with the tutor, this may indicate that students would like to have more personal feedback based on their library activity information.

Furthermore, we notice that students prefer not to share almost all data items in this category with their peers. According to Figure 4.3, the top-five less sensitive data sources are from *Library access and loan* data. For that reason, we may expect that students are willing to share this information with others. However, the participants typically do not want to communicate all that information with their peers.

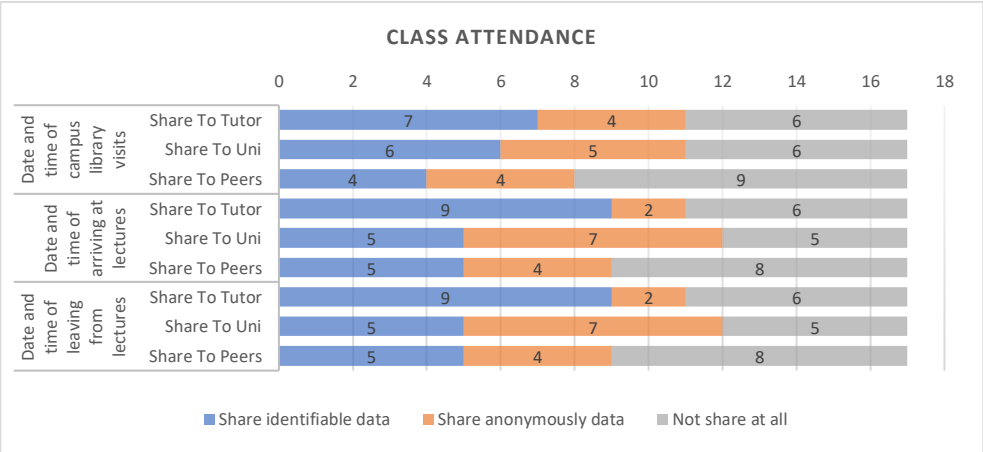


Figure 4.5. Undergraduate students' willingness to share Class Attendance data

Figure 4.5 displays students' willingness to share their *Class Attendance* data. As shown in Figure 4.5, students are willing to share the three data items with the tutor as identifiable data. Students also tend to share their data with the university either as identifiable or anonymously. Similar to the previous category, students were inclined not to share their *Class Attendance* information with their peers.

Regarding students' willingness to share their *Web Browsing History* data, which is displayed in Figure 4.6, we can see that students tend to keep the information regarding time spent accessing entertainment, social networking websites and shopping websites. That information is about the activities that may distract students from their studies, and students do not want to share it with others. However, students are willing to share information about their time spent accessing websites that may support students' performance, such as communications/scheduling, reference/learning, news/opinions, design/composition and utility websites. Similar to the *Class Attendance data* category finding, it seems that undergraduate students are unhappy to share almost all of the data items listed in this category with their peers.

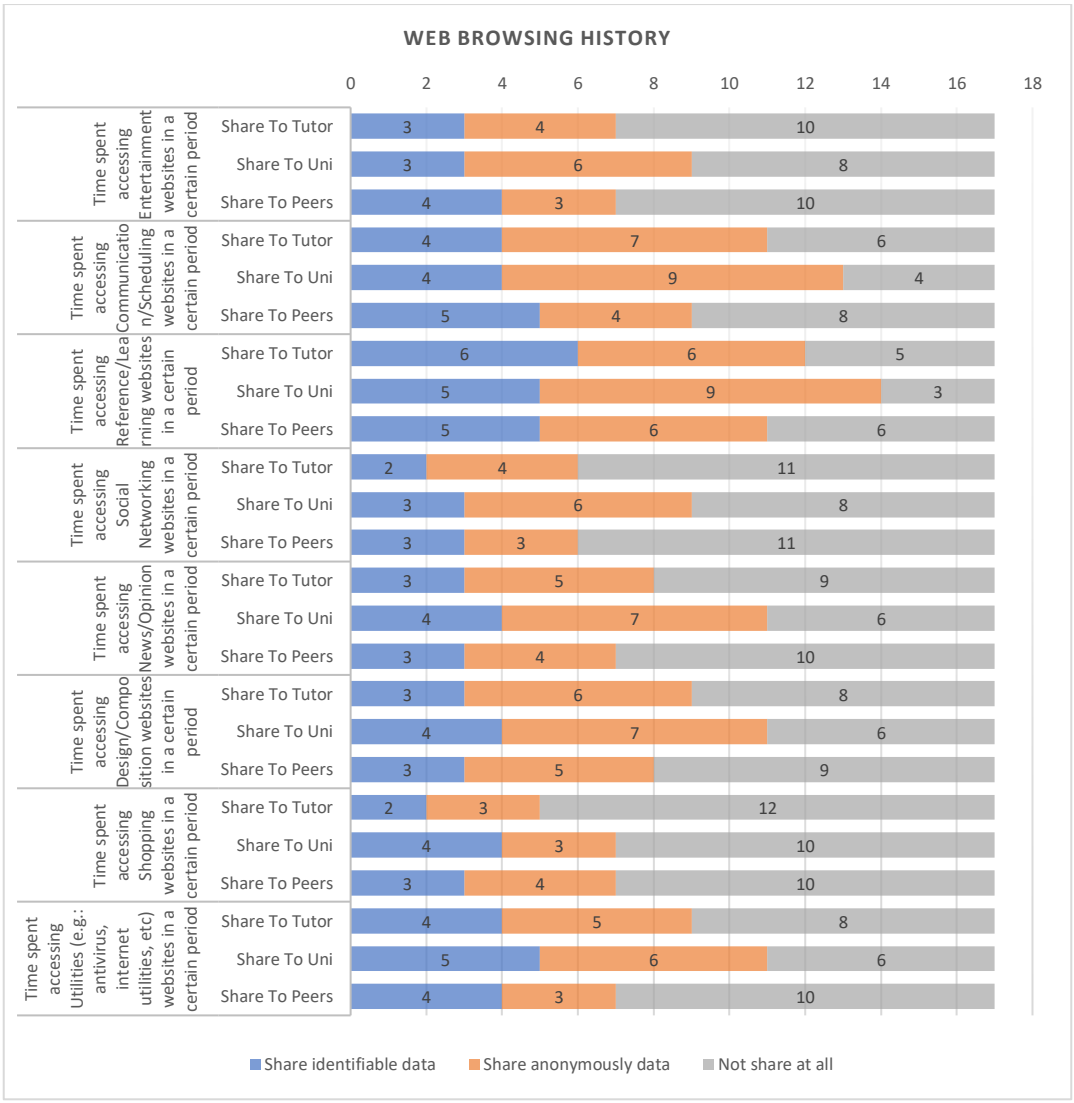


Figure 4.6. Undergraduate students' willingness to share Web Browsing History data

It is shown in Figure 4.7 that students are not willing to share almost all data items listed in the *Self-declared and tracker app* category, either with tutors, university or peers, except the data about study logs. A possible explanation for these results may be that undergraduate students consider almost all of the information in this category to contain very personal and sensitive information. This finding is consistent with what is illustrated in Figure 4.3: undergraduate students tend to consider almost all of the information in this category as sensitive information.

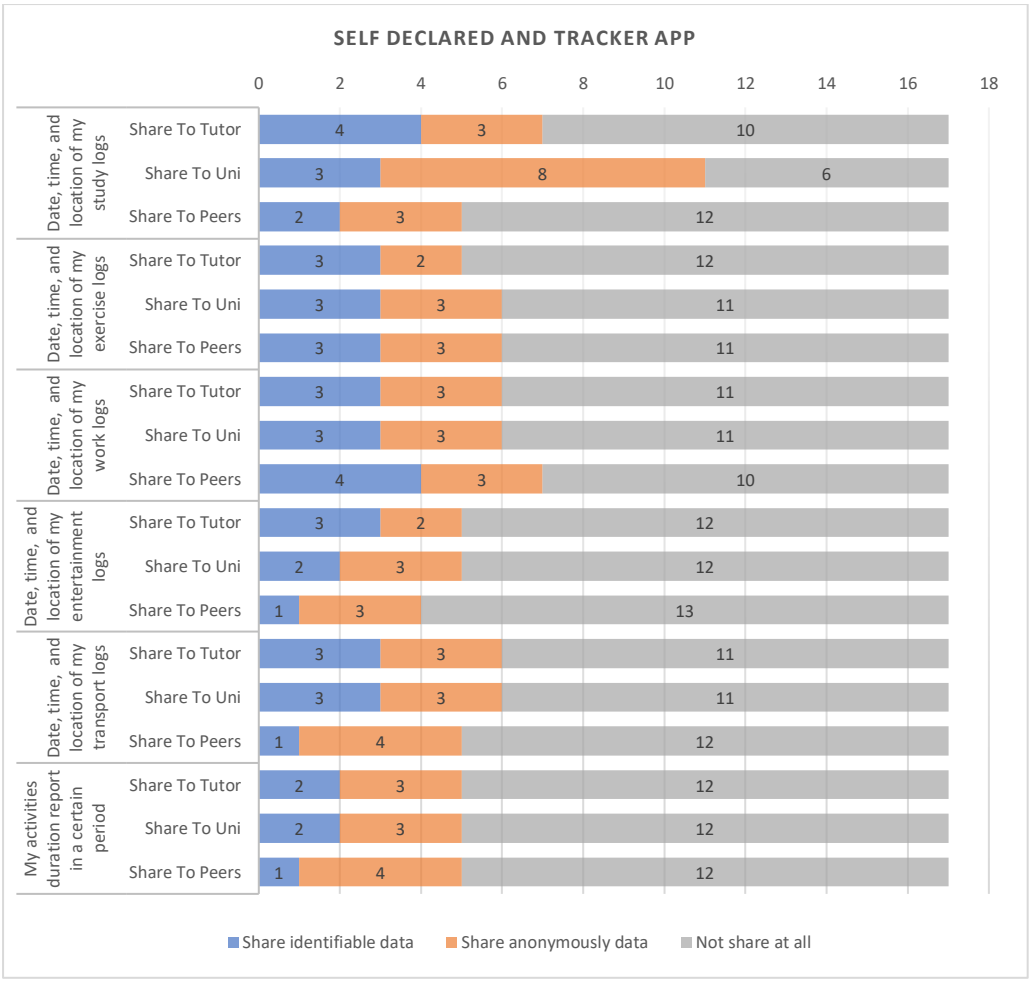


Figure 4.7. Undergraduate students' willingness to share Self-declared and Tracker app data

In Figure 4.8, we see that the undergraduate students' tendency to share information regarding *Social Network Activity* data is almost similar to that of *Self-declared and tracker app* data. Students tend not to share the information with others, either with the tutor, the university or student peers for both categories. However, students are willing to share the information about *time spent accessing Help websites* with the tutor and university anonymously. This verdict is similar to the *Web Browsing History* category in that students are willing to share information related to activities that may support students' performance.

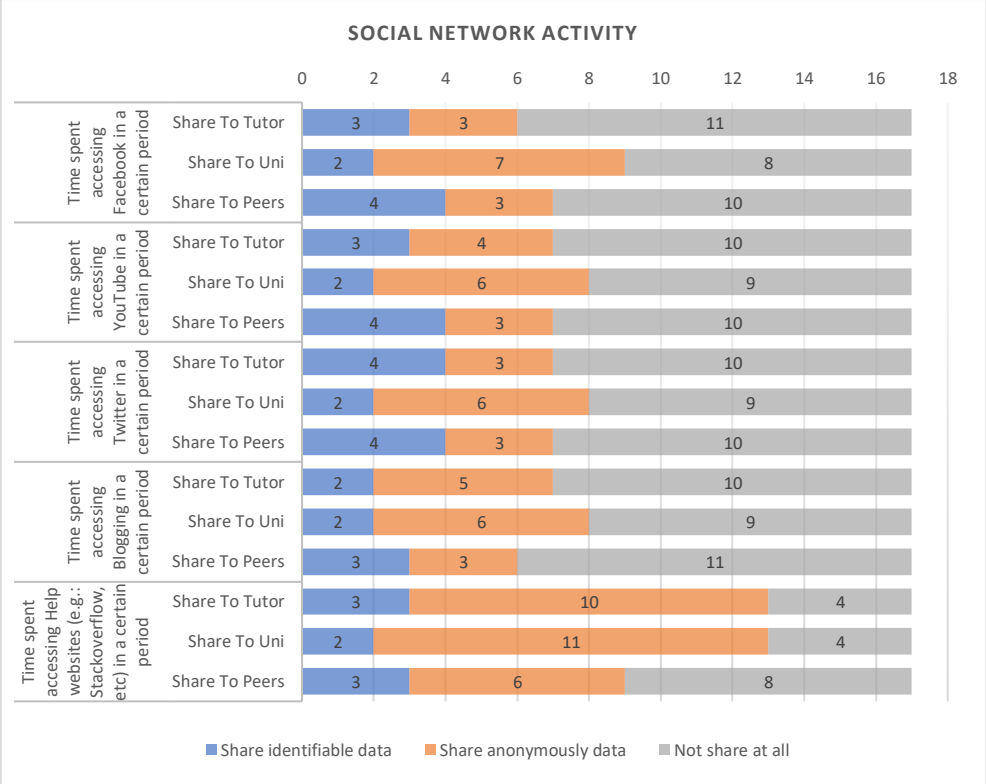


Figure 4.8. Undergraduate students' willingness to share Social Network Activity data

To sum up, from the discussion regarding the results of undergraduate student responses, we can infer that undergraduate students tend not to disclose their personal information to their peers. Furthermore, undergraduate students tend to share their information identifiably with the tutor when the data is positively related to student's performance; however, they are inclined to only share the data anonymously with the university.

4.3.3. Questionnaire analysis of master student respondents

We got 43 out of 79 responses from Master students in this research. The distribution of the subject of these Master students is illustrated in Table 4.3 below. The questionnaire responses for Master students regarding each data source's usefulness and sensitivity levels are displayed in Figure 4.9 and Figure 4.10.

School	**Mobile Phone OS familiarity**	**Frequency**
Business School	IOS	8
	Android	14

	Both mobile operating system	4
School of Engineering	Android	1
	IOS	7
	Both mobile operating system	2
Law School	IOS	1
	Both mobile operating system	1
School of Natural and Environmental Sciences	Android	1
	IOS	2
School of Medical Education	IOS	1
School of Biomedical Sciences	IOS	1

Table 4.3. Subject and mobile phone OS familiarity of master student participants

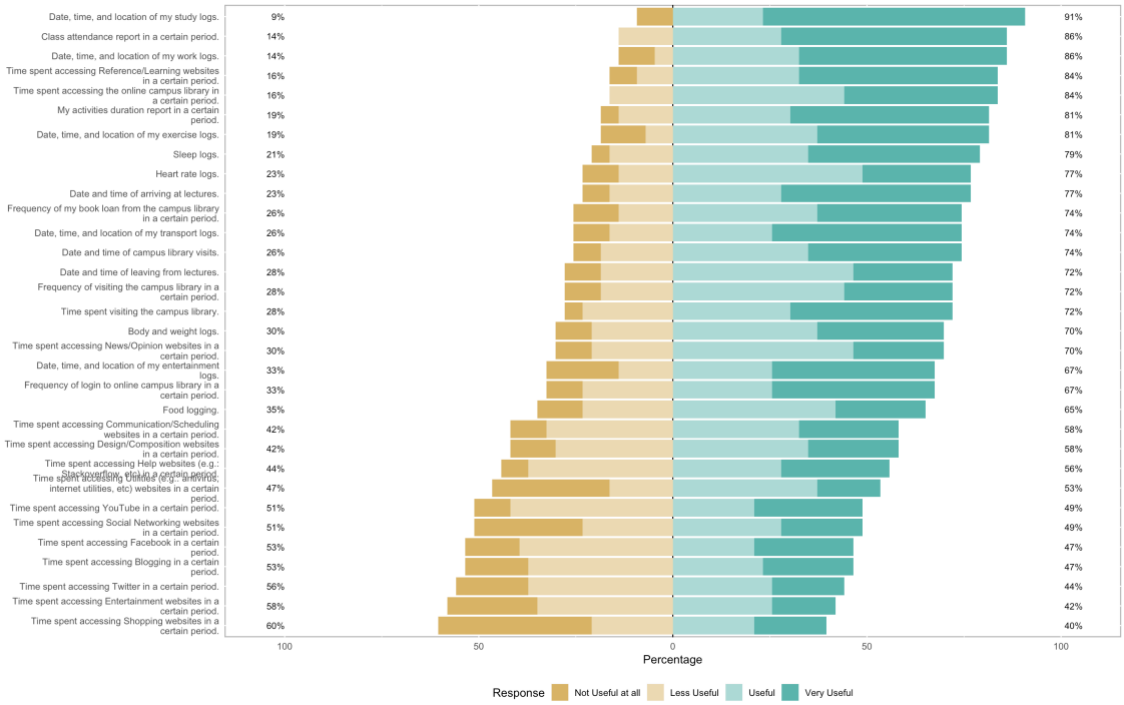


Figure 4.9. Usefulness level each data sources from Master students' response

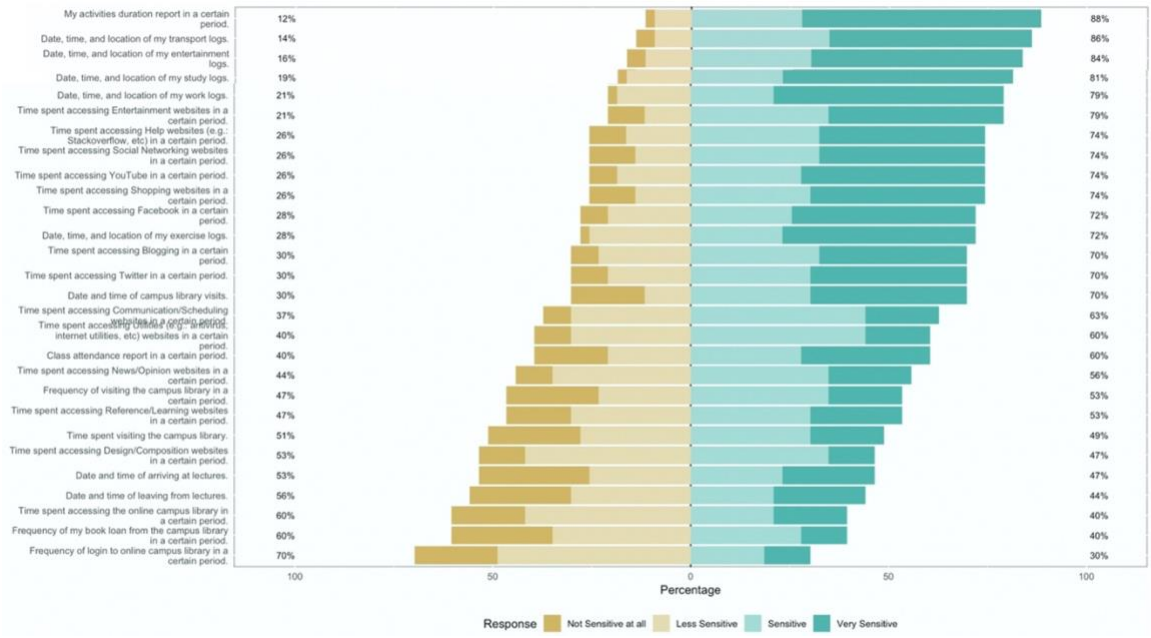


Figure 4.10. The sensitivity level of each data source from Master students' response

In Figure 4.9, we may see the top-five most useful data sources according to Master students' answers are:

- Date, time and location of study logs
- Class attendance report in a certain period
- Date, time and location of work logs
- Time spent accessing Reference/Learning websites in a certain period
- Time spent accessing the online campus library websites in a certain period

Based on the list above, the most useful data sources from master students' responses are within four categories: self-declared and tracker-app, class attendance, web browsing history and library access and loan.

From Figure 4.10, we might see that according to Master students' responses, the most sensitive data sources are from the *Self-declared and tracker-app* category. Furthermore, the less sensitive data sources are from the *Class Attendance* and *Library access and loan* category.

In this research, we also explored students' willingness to share the information about each proposed data source with others. The response from Master students regarding their willingness to share the information with others will be discussed below, one by one for each category.

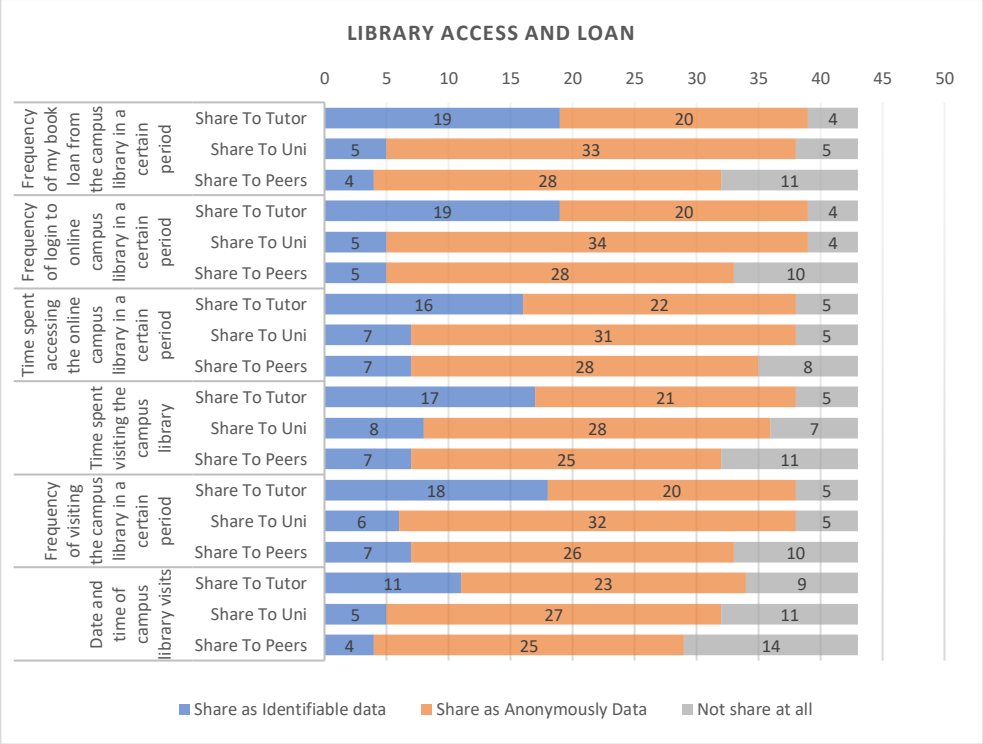


Figure 4.11. Master students' willingness to share Library Access and Loan data

As shown in Figure 4.11, students tend to share information anonymously with the tutor, university and peers. This finding seems consistent with what is illustrated in Figure 4.10 that master students tend to consider data sources from *Library access and loan* category are less sensitive.

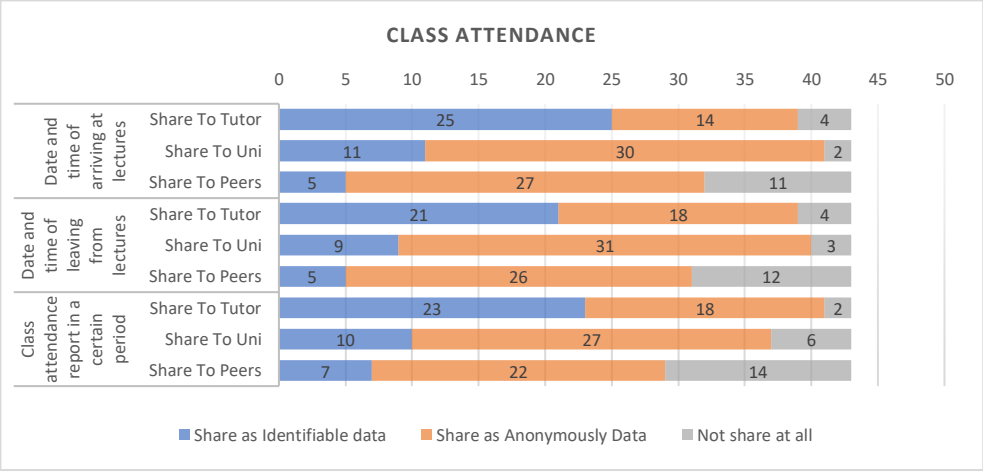


Figure 4.12. Master students' willingness to share Class Attendance data

As shown in Figure 4.12, master students are likely to disclose all data sources within the *Class Attendance* category with tutors as identifiable data. Students also preferto share the

information with university and peers anonymously. This finding seems consistent with what is illustrated in Figure 4.10 that master students tend to consider data sources from the *Class attendance* category as less sensitive information.

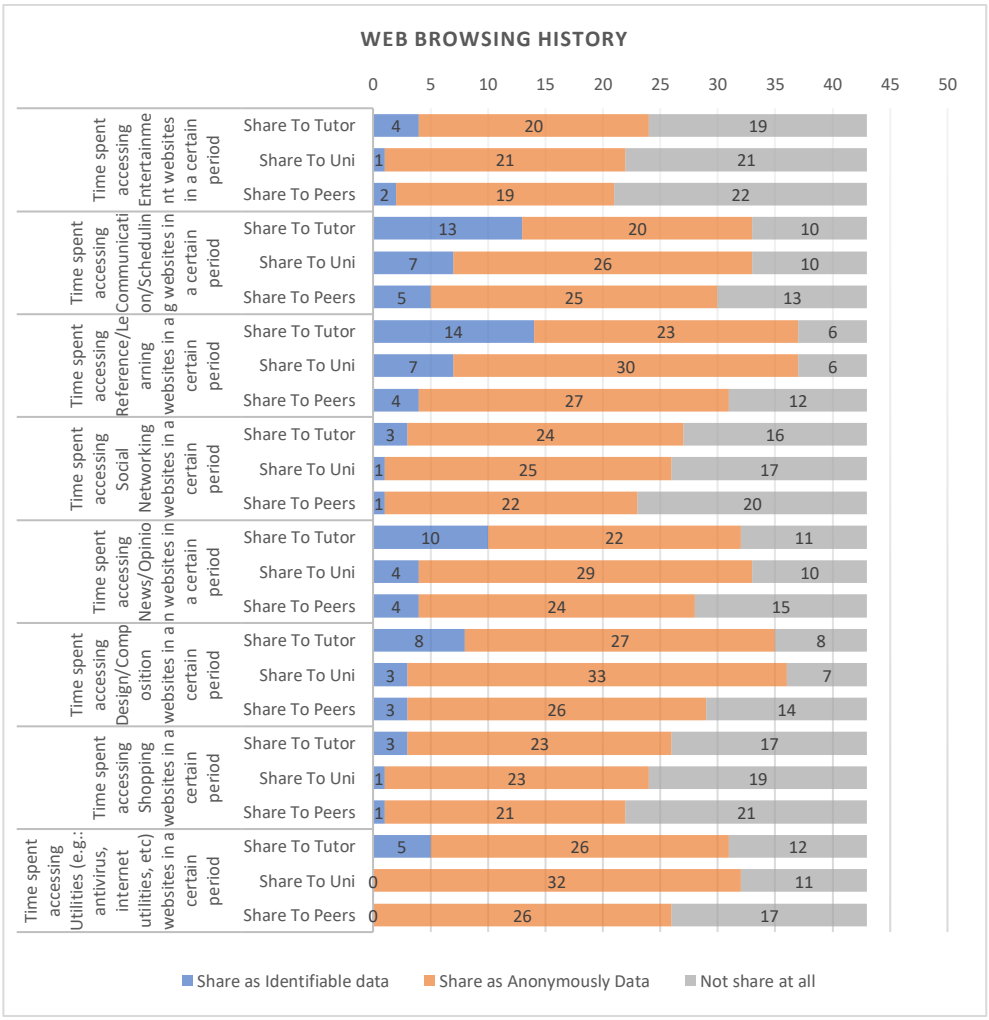


Figure 4.13. Master students' willingness to share Web Browsing History data

Regarding students' willingness to share their *Web Browsing History* data, which is displayed in Figure 4.13, we can see that students tend to disclose their information anonymously to tutor, university and peers. Regarding data sources that may be considered useful information as illustrated in Figure 4.9, e.g. *time spent accessing Communication/Scheduling* and *Time spent accessing Referencing/Learning websites*, master students prefer to share it identifiably with the tutor.

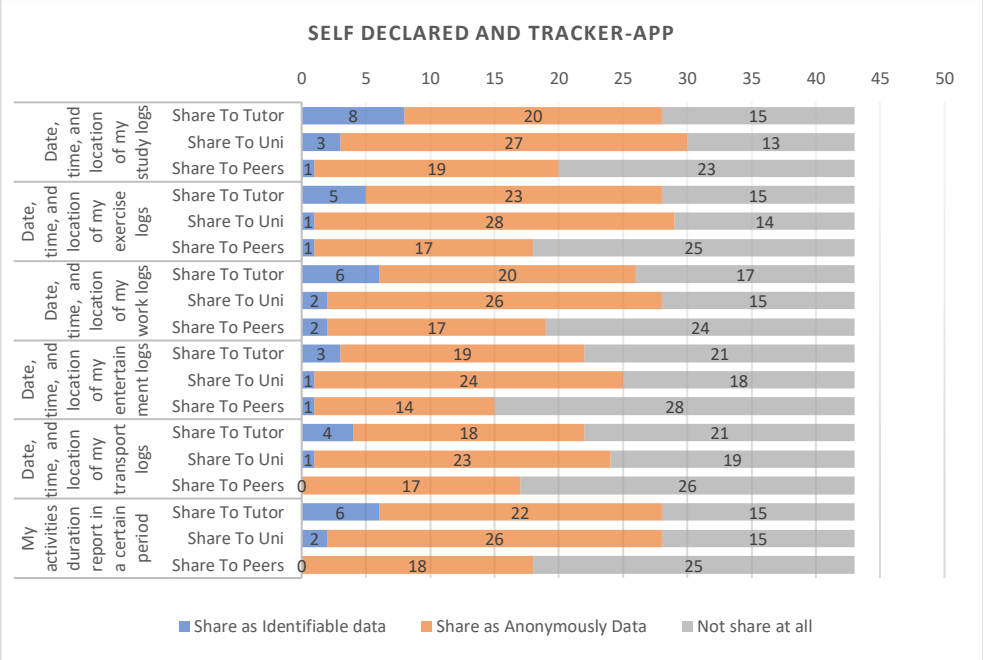


Figure 4.14. Master students' willingness to share Self-declared and Tracker app data

As shown in Figure 4.14, master students tend not to share their information with peers about all the data sources listed in the *Self-declared and tracker app* category. Interestingly, we also may see that master students tend to share all data sources in this category anonymously with the university despite their tendency to consider these data sources as very sensitive information (see Figure 4.10). However, we may also see from Figure 4.9 that master students prefer to view all of the data sources in this category as beneficial information for their self-reflection.

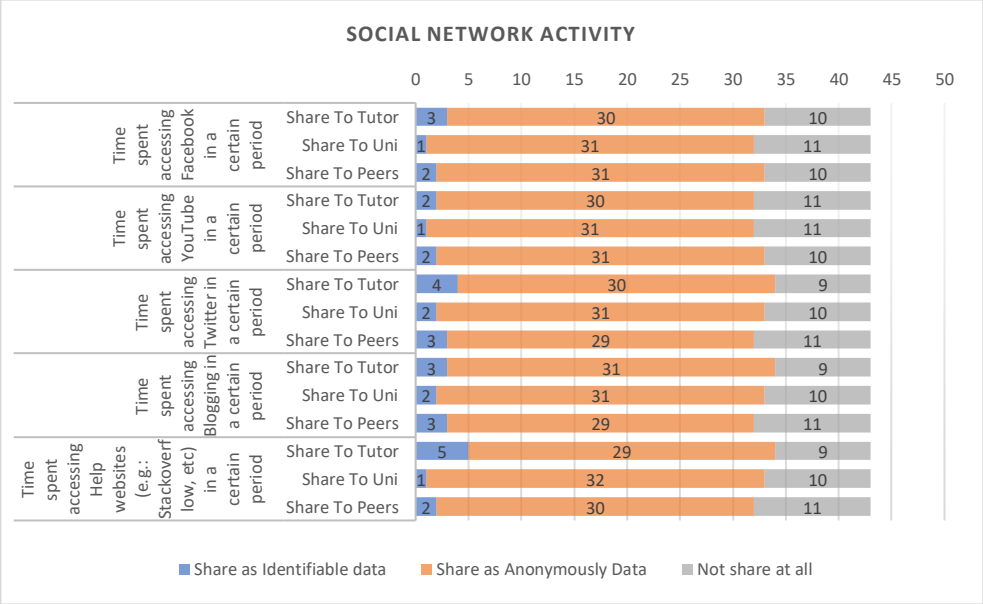


Figure 4.15. Master students' willingness to share Social Network Activity data

In Figure 4.15, we can see that students tend to disclose their information anonymously to tutor, university and peers for all data sources in *Social Network Activity* category. This verdict is interesting since master students illustrated in Figure 4.10 that they tend to consider all of the data sources in this category as sensitive information. However, regarding the usefulness of data sources in Social Network Activity, as illustrated in Figure 4.9, master students tend to consider them as less useful information for their self-reflection.

To sum up, from the discussion regarding the results of master student responses, we can infer that master students prefer to disclose their personal information to the university anonymously despite its sensitivity. However, when the data is considered very sensitive, e.g. data sources in the *Self-declared and tracker app*, master students prefer not to share it with their peers.

4.3.4. Questionnaire analysis of PhD student respondents

We got 19 out of 79 responses from PhD students in this research. The distribution of the subject of these PhD students is illustrated in Table 4.4 below. Furthermore, the questionnaire responses of PhD students are displayed in Figure 4.16 and Figure 4.17 regarding the usefulness and sensitivity of data sources.

School	**Stage**	**Mobile Phone OS familiarity**	**Frequency**
Business School	Year 2	IOS	3
	Year 3	Android	2
		IOS	1
School of Architecture, Planning and Landscape	Year 1	IOS	1
	Year 3	Both mobile operating system	1
	Year 4	Both mobile operating system	1
		Android	1
School of Mathematics, Statistics and Physics	Year 4	Android	1

School of Medical Education	Year 2	Android	1
School of Biomedical Sciences	Year 3	Android	1
School of Natural and Environmental Sciences	Year 1	Android	2
		Both mobile operating system	1
	Year 3	Both mobile operating system	3

Table 4.4. Subject, level and mobile phone OS familiarity of PhD student participants

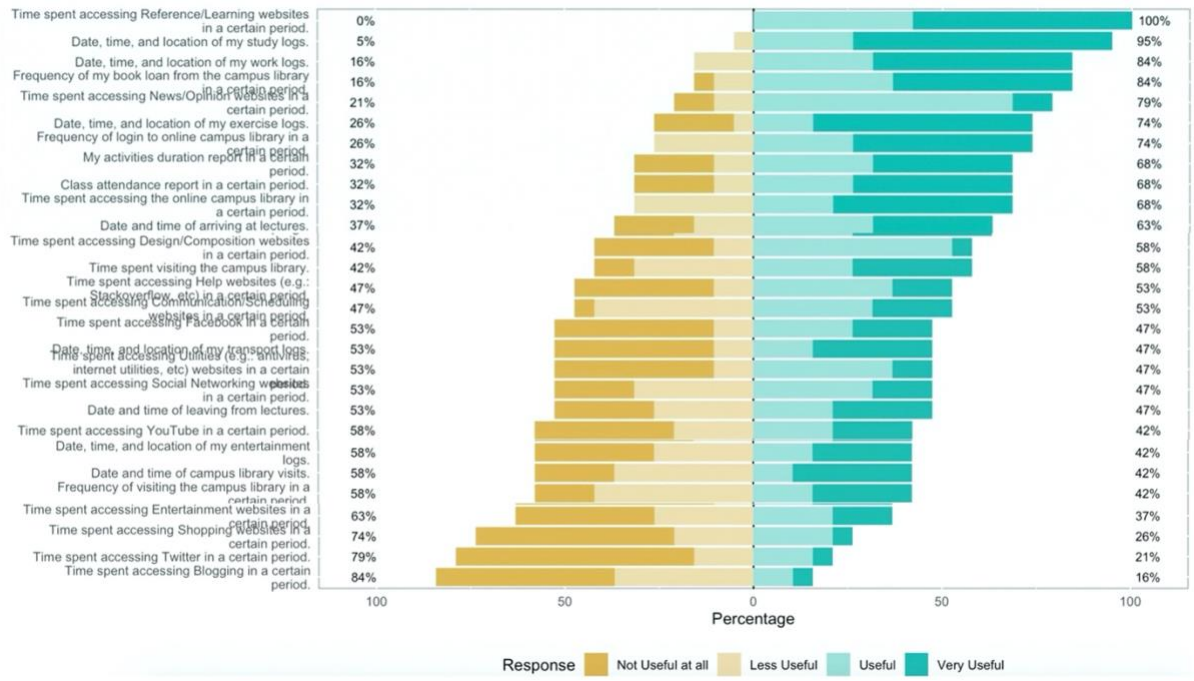


Figure 4.16. The usefulness level of each data source from PhD students' response

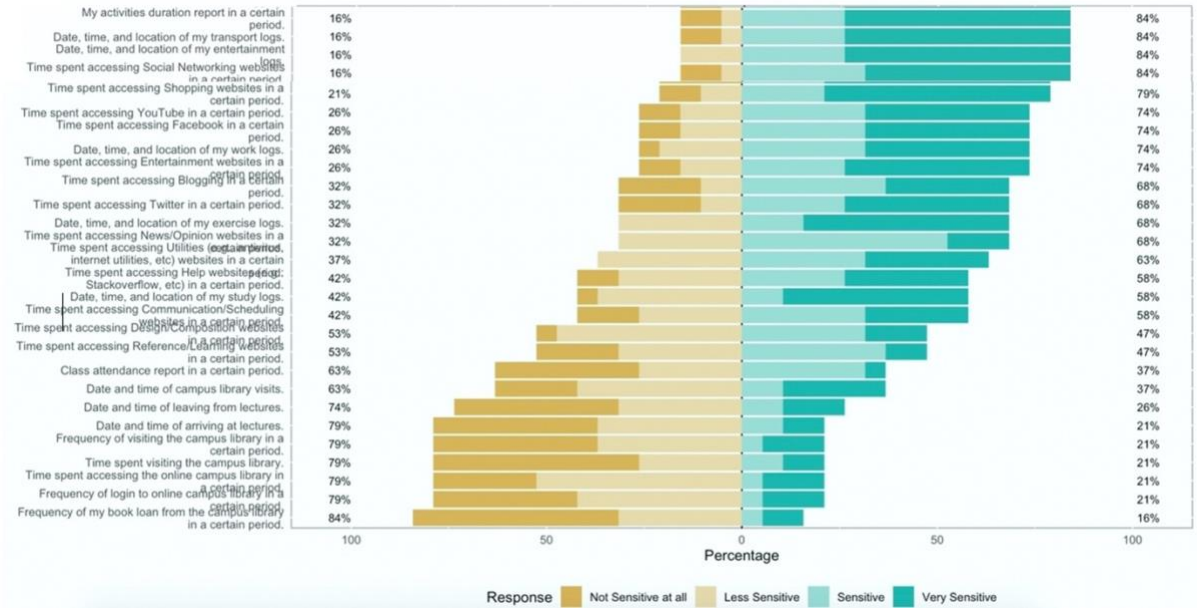


Figure 4.17. The sensitivity level of each data source from PhD students' response

In Figure 4.16, we may see the top-five most useful data sources according to PhD students' responses are:

- Time spent accessing Reference / Learning websites in a certain period
- Date, time and location of study logs
- Date, time and location of work logs
- Frequency of book loan from the campus library in a certain period
- Time spent accessing News / Opinion websites in a certain period

Based on the list above, the most useful data sources from PhD students' responses are within four categories: web browsing history, self-declared and tracker-app, and library access and loan.

From Figure 4.17, we might see that the most sensitive data sources are from *Self-declared and tracker-app* according to PhD students' responses. Interestingly, this finding is similar to Master and Undergraduate students' responses. Furthermore, in PhD students' responses, the less sensitive data sources are from the *Class Attendance* and *Library access and loan* categories, similar to that of Master and Undergraduate students.

In this research, we also explored students' willingness to share the information about each proposed data source with others. The responses from PhD students regarding their

willingness to share the information with others will be discussed below, one by one for each category.

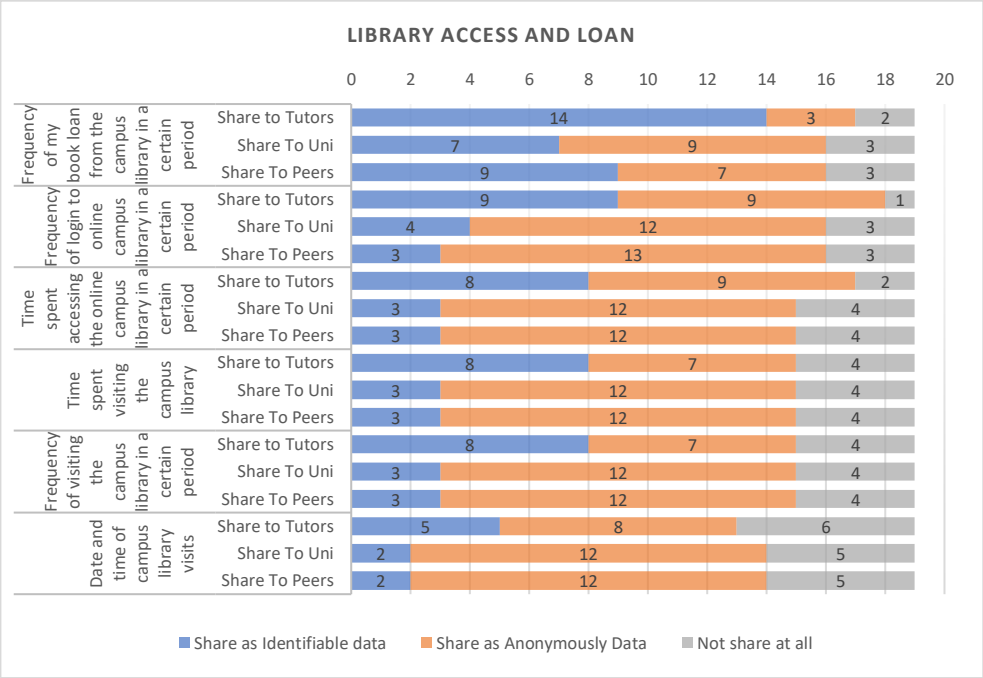


Figure 4.18. PhD students' willingness to share Library Access and Loan data

We can see from Figure 4.18 that PhD students tend to share information anonymously with the university and peers. Furthermore, PhD students tend to share their identifiable information with their tutor. This finding seems consistent with what is illustrated in Figure 4.17 that PhD students tend to consider data sources from *Library access and loan* category are less sensitive.

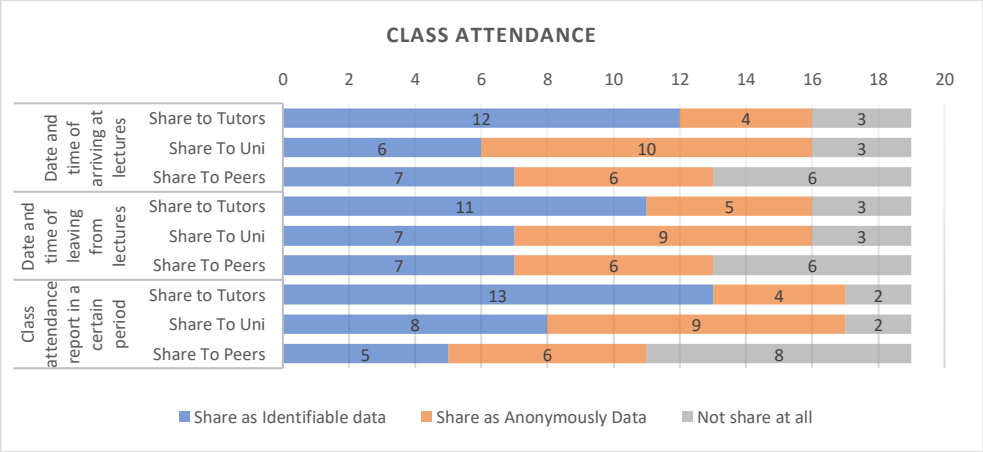


Figure 4.19. PhD students' willingness to share Class Attendance data

As shown in Figure 4.19, PhD students are likely to disclose all data sources within the *Class Attendance* category with tutors as identifiable data. PhD Students also prefer to share *Class Attendance* information with university and peers anonymously. This finding seems consistent with what is illustrated in Figure 4.16 and Figure 4.17 that PhD students tend to consider data sources from *the Class attendance category to be* very useful but less sensitive information.

Figure 4.20 show that PhD students tend to disclose their information anonymously with the tutor for the data sources considered very useful but less sensitive information, e.g. *time spent accessing Reference/Learning* websites. However, PhD students tend not to share their information with their tutor, university, or peers when the data sources are considered less useful but very sensitive information. For example, *time spent accessing Entertainment websites, time spent accessing Social Networking websites, time spent accessing Shopping websites.*

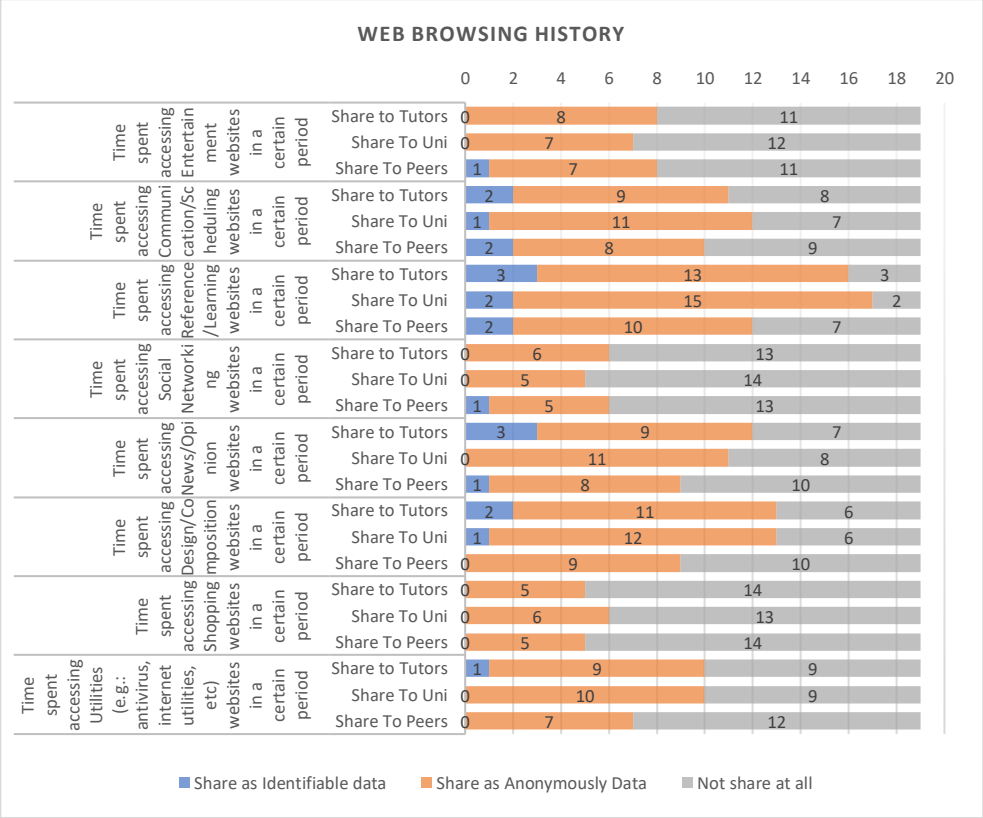


Figure 4.20. PhD students' willingness to share Web Browsing History data

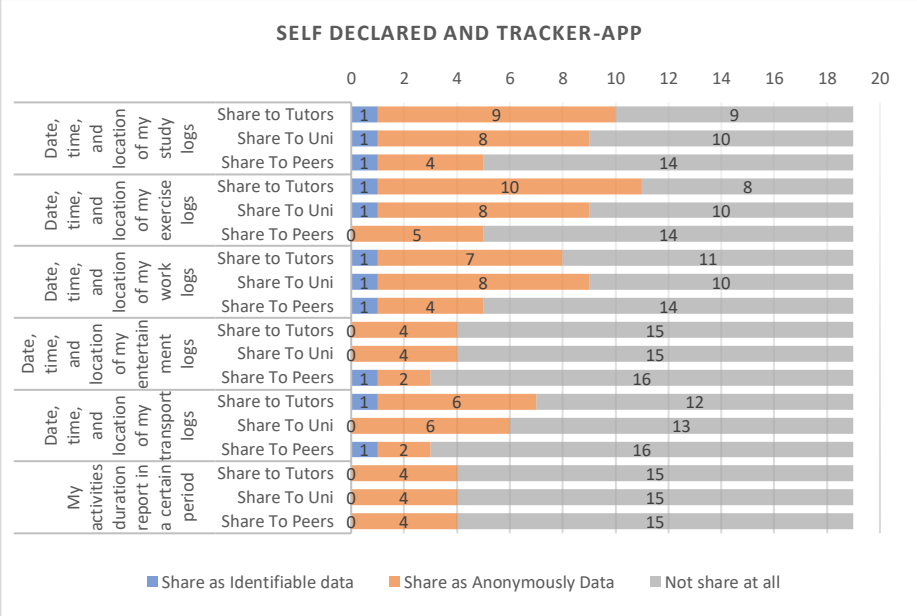


Figure 4.21. PhD students' willingness to share Self-declared and Tracker app data

As shown in Figure 4.21, PhD students prefer not to share their information with peers for data sources in the *Self-declared and tracker app* category, except those related to study and exercise logs. Regarding the date, time, and location of study logs and exercise logs, PhD students tend to share the information anonymously with their tutor despite what is illustrated in Figure 4.17. They tend to consider all data sources in the *Self-declared and tracker app* category as very sensitive information. However, we may also see from Figure 4.16 that PhD students tend to view the two data sources mentioned above as very useful information for their self-reflection.

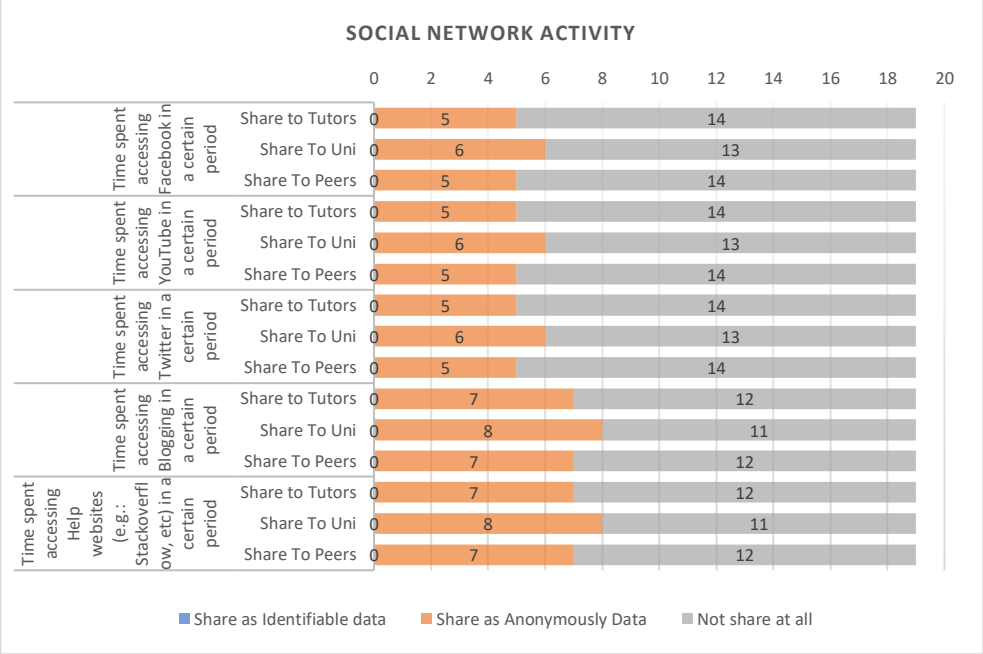


Figure 4.22. PhD students' willingness to share Social Network Activity data

In Figure 4.22, it is obviously shown that none of PhD student participants in this study would like to share their identifiable information with others. Furthermore, we can see that PhD students tend not to disclose their data with the tutor, the university, and peers for all data sources under the *Social Network Activity* category. This verdict is consistent with what is illustrated in Figure 4.17: PhD students tend to consider all data sources in this category as very sensitive information. PhD students also tend to think data sources in this category are not helpful for their self-reflection.

To sum up, from the discussion regarding the results of PhD student responses, we can infer that PhD students tend not to disclose their personal information to others when they consider the information is sensitive/highly sensitive and less/not useful for self-reflection. However, when the data is considered less sensitive but valuable for self-reflection, PhD students tend to share it anonymously with their tutor and the university.

4.4. Discussions

There are numerous data sources from non-VLE activities that might help students for self-reflection in order to manage their time. Our study examines a range of data sources, including information on students' online and offline activities as well as their physical activities. Students could be hesitant to share certain data sources with others because they

perceive the information as being sensitive. This first stage of our study aims to comprehend how students feel about how sensitive the material is to them and whether they are willing to share it with others. Furthermore, we also investigated the students' expectations towards those data sources to determine which information to be displayed in students Time Management app.

We conduct an online survey with students to gather information. To evaluate the result and better understand the connections between the data, visualization tools are used. In chapter 4.3, "Data Analysis," the results of the questionnaire are described, along with their visualization. Among better understand the behavior of the cohorts, we dispersed the data to undergraduate, master's, and PhD students.

4.4.1. *What are students' views regarding data privacy and how do they want to disclose the data from different sources outside a VLE in their time management apps?*

This research analyses the students in three groups of degree level, undergraduate, master and PhD students. We did this to get the perceptions of each group since they might have their own characteristics that are different from each other. According to the questionnaire results mentioned above, undergraduate students prefer not to share their data with peers. Even when the data is considered not to be sensitive information, such as 'Time spent visiting campus library', the undergraduate students prefer to not disclose this to their peers. Still, they prefer to share their data with the tutors and the university, particularly when the data may show the students' productivity.

Derlega et al. (2011) investigated information disclosure among college students, to whom they disclose this information, and why. Relational factors (e.g., Close Relationship/ Emotional Closeness, Similarities in Experiences or Interests, Knowledge Sharing) were frequently mentioned as reasons for disclosure. However, self-related factors (e.g., Avoiding Negative Reaction – Self-focus, Privacy) were frequently mentioned as reasons for not disclosing information. Hence, the undergraduate students in our study tend not to reveal their data with peers although it is not sensitive. We may assume that self-related factors may cause this (e.g., Avoiding Negative Reactions – Self-focus, Privacy), as Derlega et al. (2011) reported.

Vitak and Kim (2014) researched disclosing information among graduate students. As their sample was comprised of graduate students many of whom had befriended faculty members and previous or current students, the participants were highly aware of their self-presentation online. They were concerned about an existing or potential audience viewing their content. Therefore, they want to portray their image as a professional when self-disclosing their information online.

Accordingly, in our study, the Masters and PhD students are also sensitive when disclosing their information to others. They prefer to share their data anonymously rather than identifiably. Master students are generally happy to share their data anonymously with tutors, university and peers, except those data items in self-declared and tracker apps. PhD students are likely to be more cautious when sharing their data with others. There is a tendency for PhD students to not share the data items at all with tutors, university and peers if they consider the data to contain sensitive information. However, when the information is considered less sensitive but valuable for self-reflection, PhD students tend to share it anonymously with their tutor and the university.

According to Cho et al. (2018), there is a privacy calculus between undergraduate students' intentions to share their information and their privacy concerns. The perceived privacy issue and perceived values influenced the users' intentions to release information. Cho et al. (2018) claim that perceived privacy concerns had a detrimental impact on perceived value from the viewpoint of their students. Additionally, perceived value had a higher impact on information disclosure than perceived privacy issues. Therefore, if they believe the benefits outweigh the privacy issues, pupils are more inclined to give their information.

Our research supports the findings from Cho et al. (2018) that students' intentions to reveal information are influenced by their perceptions of privacy. The students' desire to share their information with others is reduced by privacy concerns. For instance, in our study, all student groups were regarded as having less sensitive information on *Class Attendance* and *Library Access and* Loans. As a result, most of students have a tendency to allow sharing this information with others. Interestingly, while believing it to be less sensitive, undergraduate students tend to keep this information to themselves. The fact that undergraduate students do not opt to share information with peers may be due to their opinion that there is little value in doing so.

4.4.2. The data sources that students expected for their personal learning analytics app

With a growing interest in learning analytics systems used by higher education institutions, it is essential to understand the students' expectations as the application user. The importance of focusing on meeting user expectations has been demonstrated in technology adoption research (Almaiah et al., 2019). Users' perceived usefulness is a key predictor for behavioural intention, use, and satisfaction. Therefore, in this study we investigated the data sources expected by students to be useful for their personal learning analytics app.

From the data mentioned above, we may notice that the highest positive values of undergraduate students' responses are class attendance report, date-time and location of work, exercise, and study. Furthermore, the second-highest positive values are time spent accessing Social Networking websites and date-time and the location of study. More than half of undergraduate students believe that data sources are less useful information: time spent accessing YouTube and Blogging, frequency of login to the online campus library, and time spent accessing Utilities and Design/Composition websites.

Furthermore, 91% of Masters students believe that date, time, and study location are useful information for their self-reflection. The high ranking of this data source could mean that students need a study journal that can help them track their study time. Furthermore, they also confirm that class attendance reports and date and time of work logs are important information for self-reflection. Unlike the undergraduate students, masters students tend to consider the time spent accessing Reference/Learning websites as useful information instead of time spent accessing social network websites.

Of the PhD responses, our study reveals that 100% of PhD students consider the time spent accessing reference/learning websites as a valuable data source for their self-reflection. They also believe that date, time and location of study and work are essential to support their learning analytics. Furthermore, we may observe that mainly PhD responses consider data sources are low-rank useful information, such as time spent accessing blogging, Twitter, shopping websites, entertainment websites, etc.

This study indicates that undergraduate and masters students are likely to see class attendance reports as highly useful information. This indication makes sense since both study-levels have more class meetings than at PhD degree level. This study also indicates that undergraduate students are likely to consider time spent accessing social network websites as highly useful information. However, masters and PhD students tend to believe that time spent accessing social networks is lower less useful. These cohorts, masters and PhD students, are likely to consider data related to activities that can increase students' productivity and performance as useful information. Those activities are, for example, time spent accessing online campus library, news/opinion websites, reference/learning websites, etc.

This verdict makes sense since studying at higher levels, e.g. masters and PhD students, have a more significant workload. In the same vein, according to Chen et al. (2015), undergraduate students have higher social media usage compared to graduate students. Therefore, the time spent accessing social network websites likely is considered more important information for undergraduate students for their self-reflection in Time Management.

Data Sources	Undergraduate Students	Master Students	PhD students
Time spent accessing the online campus library websites in a certain period		v	
Frequency of book loan from the campus library in a certain period			v
Class attendance report in a certain period	v	v	
Time spent accessing Reference / Learning websites in a certain period		v	v
Time spent accessing News / Opinion websites in a certain period			v
Time spent accessing social networking websites in a certain period	v		
Date, time and location of study logs	v	v	v
Date, time and location of work logs	v	v	v
Date, time and location of exercise logs	v		

Table 4.5.Top 5 most-useful data sources. The order below does not reflect their rank

To select which data sources will be explored further, we compare the top-five most useful data sources according to undergraduate, master and PhD students. This comparison is shown in Table 4.5. We consider using the *Date, time and location of study logs* and *Date, time and location of work logs* as data sources that will be further explored and implemented into the apps. These two data sources are considered helpful for self-reflection by all degree level students in our study.

Chapter 5. Design consideration for Students' Self-reflection on Time Management App

This chapter addresses the third research question: "*What are students' preference regarding the UI design, navigation and the content of students' time management app?"*. Answering this question required further investigation into how student users perceive and expect the features, mechanisms, and data related to study and work that will be managed in the app. Several group discussions were performed to explore the students' perception of the app supporting self-reflection on their time management. The purpose of this chapter is to develop design considerations about the app's content from the students' voices.

Although the previous online questionnaire answered by students illustrated to some extent how students expect the data and sharing mechanism inside their time management apps, this was brief and general. It meant there was no room to explore details from the recorded data and information that students would like to have and to share with others. Since it is essential that the students, as potential users, must trust the proposed app, we need to listen to what queries or doubts students might have about how such an app works and how it could be improved.

Since this app's primary purpose is to support students' time management, it is reasonable to go beyond technical possibilities while considering the students' expectations of features (Ferguson and Shum, 2012). In this second study, features and students' expectations were investigated through group discussions. The students' voices in this study are then used to build design considerations for the personal students' time management app.

5.1. Data Collection

5.1.1. Materials and Procedure

The group discussions took place in an Urban Science Building meeting room at Newcastle University between September and October 2019. At the beginning of each group discussion, there was a 5-minute presentation of the introduction and similar apps to help them be aware of the research topic. The consent form, guidance and the structure of questions for the discussions are included in Appendix B. There are three groups to discuss

some considerations from the students' view. Table 5.1. shows the format, duration and participants of each group discussion.

Sessions	Format	Duration	Number of Participants
Group discussion 1	In-person meeting	58.33 mins	4 Master students 1 PhD student
Group discussion 2	In-person meeting	54.10 mins	6 Undergraduate students
Group discussion 3	In-person meeting	1 h 35 mins	8 Master students 1 PhD student

Table 5.1 Group sessions details

5.1.2. Participants

Participants were selected from the students that filled out our previous questionnaire and then extended using snowball sampling. Table 5.2. shows the participants' demographic information.

Degree Level	Gender	Age Range	Frequency
Undergraduate students	Female	18-23	3
	Male	18-23	3
Master students	Female	18-23	1
		24-29	8
		>=30	2
	Male	24-29	1
PhD students	Female	>30	2

Table 5.2 Participants' demographic information

5.2. Data Analysis

5.2.1. Transcription

The students' group discussions were audio-recorded, using high-quality playback equipment and were transcribed. All the sections, including the presentation before the

meeting, were also transcribed. The reason for transcribing the presentation was to capture the participants' initial reactions towards the research results and the whole concept and idea of a self-reflection app for students. This transcription also helped to confirm and triangulate the notions behind some of the arguments presented in this thesis.

5.2.2. Thematic Analysis

After transcription, thematic analysis was carried out towards the qualitative focus group data. Theme searching is much more than merely summarising the data: thematic analysis is also aims to interpret and make sense of it. The themes might also be obtained from general agreement or disagreement and inconsistencies in participants' statements. In other words, the theme categories may be driven by the emerging ideas which are not yet dealt with by the existing literature (Bektik, 2017).

The goal of thematic analysis is to find repeated meanings across a data set, which is crucial to the interpretation of phenomena (Vaismoradi et al., 2013). Thematic analysis also involves identifying themes, i.e. patterns in the primary data, and uses them to address the research or to say something about an issue (Clarke and Braun, 2013). Therefore, the theme categories may be driven by the data (i.e. inductive approach) or by the existing literature or research questions (i.e. deductive approach). In reality, it is almost impossible to conduct the inductive and deductive thematic analysis approach entirely (Braun and Clarke, 2021) because we always have something from the data being analysed. Terry et al., (2017) reported that the themes in the deductive thematic analysis might be derived from the research questions and literature review. In this study, the questions in our group discussions were guided by a set of topic defined by the author's research interest to investigate the design considerations for certain aspects of time management apps.

There are four topics in this study that were used to guide the questions in the group discussions:

1. Students' attitude towards the location tracking mode that is used to record students' location in time management apps.

   Our previous study shows that students expect that time management apps can record their date, time and location of their study and work logs. The use of location data to build daily timeline activities may help students to recall what activities they did when recording their activities. Although location tracking has been used by many

application that are popular, such as Pokemon Go![12], Uber[13], Google Maps[14], Waze[15], etc., many users have different opinions regarding their preference to use apps with location tracking features. In the group discussions, the participants' opinions and reasons were discussed to investigate their preferences with respect to the location tracking feature in time management apps.

2. Students' attitude towards the potential for data sharing with others (personal tutor, university, and peers).

   The findings from online questionnaire that was conducted previously only show how students want to disclose the potential data sources with tutor, university and peers for students' time management app. To implement the design of the app, more exploration of the data sharing feature is needed.

3. Students' attitude towards gamification scenarios for improving their motivation to use the app

   To improve the students' engagement with the app, gamification is an alternative strategy that could be implemented. The implementation of a gamification scenario needs to be considered carefully so as to add an enjoyable aspect that leads to motivating users to use the app. Furthermore, the motivation in gamification is also supposed not to be too strong, as this may encourage students to deceive the app to get more score or reward.

4. Students' expectations of other features that may complement the time management app.

   The students were asked about other features that they wanted in the time management app. They were also asked to prioritise those features to be further implemented.

NVivo 12[16] was used in this study to help analyse this qualitative data. This software helps us to work efficiently with a large amount of text and coding schemes to develop depth analysis. The discussions was anonymised as described in the consent form given to the participants. Braun and Clarke (2012) suggested that the transcript was read thoroughly to familiarize myself with the data. The textual data were then highlighted and extracted into

[12] https://pokemongolive.com/en/
[13] https://www.uber.com/
[14] https://maps.google.com/
[15] https://www.waze.com/
[16] https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home

code. These codes were then examined and summarised into relevant themes already defined (Kiger and Varpio, 2020). The author identified the initial coding and then was reviewed through multiple reviews by advisors to ensure that all textual data is already examined thoroughly and summarised to relevant themes.

The themes and relevant excerpts derived from the qualitative analysis of the focus group sessions are explained below.

5.2.3. Theme 1: Location Tracking

The first global theme is related to the location tracking options that the students preferred for the app. In the discussions, we asked about the location tracking mode, whether it should be automatic location tracking, semi-automatic location tracking or no tracking at all. The students outlined their preferences for location tracking mode and their reasons forthem. During the focus group session, participants also spoke about their concerns regarding tracking accuracy.

Some students prefer that their location be recorded once they permit the apps to do so. The reasons behind this are varied, including simplifying the required action since they do not need to check the app every time, get a picture of their daily stats precisely, and feel more secure since the students still feel very young and are often living far from their parents.

Student04 *"…so if it is only for me, I would like to make it automatic, so I can like have insight, how was my performance for a day, because as a PhD students sometime we have like an ordinary date activities similar day by day, so but when it like comparing target and performance of how we spend time every day like what I'm doing, how much I spend to work in probably library, or my office or my class, so it is really important for me to have inside what I'm doing …"*

Student06 *"…I like automatic location tracking better. For me, it is way simpler to access and I don't think that the information is sensitive enough considering it is educational related…"*

Student08 *"…the automatic one can add more safety with us, because if you maybe you get kidnapped or something like that, it can track you rather than the semi-automatic …"*

Student20 *"…I prefer fully-automatic because I am not a well-managed person and I think it will help me to manage everything like study tracker, health tracker, or you may say like*

sleep, eat, study, internet, housework, you know. It is because for me, if I use the kind of apps, it helps me a lot…"

Some students pointed out that they prefer to have semi-automatic location tracking. This was because the students want to ensure location accuracy by approving only locations that are detected correctly. If the app detects the location imprecisely, they are still able to correct it. Students want to have flexibility by using the on-off mode in location tracking, so they are not tracked continually 24/7. Sometimes students want their location to be recorded, but not all of the time. With the feature to set the location tracking off, students feel the app supports their privacy in a better way. Students also stated that saving battery power is why they want to have semi-automatic location tracking features. Taken together, it seems that students feel that they have more authority to control the app when using semi-automatic location tracking.

Student03 *"I want the semi automation tracking because I want to know my activity for a day, but I want to make sure that my location is precise …"*

Student07 *"for me, personally I prefer the semi-automatic one, reflecting that I don't want to be tracked automatically for 24/7 non-stop."*

Student17 *"For me, it is the same that I prefer to choose the semi-automatic because it is personal majority and sometimes, I don't want to, I don't want my activity to be recorded by my phone and also, I always have a problem with my battery in my phone."*

Student19 *"For me, I prefer the semi-automatic one, because we are sometimes that I want to go record it, but sometimes I don't want to record it. So, I just want to be flexible, so that's it."*

Some participants prefer a manual mechanism as they do not want their location to be detected automatically by the app. The participants reported that their concern is related to the privacy aspect.

Student01 *"I prefer to use manual tracking app because I'm a bit conservative about data privacy … so manual tracking will be, will suit me because I can fully control to my plan of my activities, and again I can control what places I visited which is recorded in my app."*

Student11 *"for me, I prefer the manual tracking because I think we have more privacy with the manual one."*

5.2.4. Theme 2: Data sharing with others

In many information systems, users face decisions that trade privacy with benefits (Hirschprung et al., 2016). A typical exchange occurs in electronic commerce, where customers trade off their private information for rewards (Zhao et al., 2019). Elliot et al., (2021) also mentioned that some companies offer customers the ability to share their information, so that the customer can get personalised discounts in return.

This second theme is about the data sharing with others. In the group discussions we asked the participants preferences regarding the data sharing mechanism, whether they want to share it with including their identity, anonymously or have no sharing at all. The students talked about their options and the reasons why they choose those mechanisms. The students also talked about the type of information that could be shared and information that is supposed not to be disclosed to others.

In this study, participants talked about the data that they did not mind being disclosed to others. They pointed out that the time and duration of activities is appropriate data to be shown to their personal tutor or university. Moreover, students do not want to share their location data due to their privacy and their concern regarding location tracking accuracy.

Student04 *"I prefer sharing like how much time I spend for what kind of activities, what type of activity and time spending for each activity."*

Student12 *"…the detail like what kind of topic that we discuss on the lecturer, on the seminar or something, then it will be like forbidden to be shared. But if we only share .. just like .. we do the conference for three hours, we do study for five hours, it's okay."*

Student13 *"I would say in study, time. Location wouldn't be appropriate to share with the others. But the duration, it's fine with me. For example, how much did I spend in study, how much time did I spend in the library, how I spent with my journals. By work, I don't think time and location would be appropriate to be shared. Like, I don't want my colleagues to know how much I spent time for working, or where my, mm, places for working."*

Student14 *"I would like to share my activities but not too details and only in the scope of university activities. But the rest, I think it is personal. So, I don't think if we share like location, or the time or duration of our activities is also useful for the others."*

In addition, students also expressed their willingness to reveal the information to their tutor and university. Getting personal feedback is the main reason why students are willing to disclose information related to study and work activities.

Student06 *"I don't think that the information is sensitive enough considering it is educational related, so, I think that the university or personal tutor or lecturer should know. I mean like I don't mind for that, and its way simpler because I don't need to control it, because I feel have to work on my work as well, uni-works. When I come about the education, I think the university and all staffs related should have to know what I do."*

Student08 *"I think same (with her), as long as it's not about my private information, I will share anything to them. But if we need feedback to the personal tutor or teacher, I would like to put my identity because they can really know whose score is this."*

Student10 *"well, same as him because I think the university need to know our personal identity. Like, if something wrong with us, here, we don't have parents here, so the university is the closest can take us as parents here."*

Student15 *"I think we can share in terms of sharing the activities of studies, not other things. So, if it is about study or our work in the university, it is alright I think to share with tutor with identity."*

Student18 *"let say the university, the Newcastle university build this app, I think I'd say that I will be okay if I reveal my identity because I will get personal feedback from my tutor. I think it's okay for reveal my identity as long as I get the feedback. But, if it's just to my tutor and lecture, but not for my peers."*

Other students showed their reluctance to disclose their information unless there is a mandatory rule to share the info with a tutor or the university.

Student03 *"And I also prefer not to share my data because I think it is also privacy and .. unless it is mandatory, mandatory for personal purpose in the course or asked by personal tutor itself, I may share it only with personal tutor."*

Student13 *"if it is only provided for tutors, .. only for tutor, yes .. because I don't mind sharing my personal problems, or personal data or personal .. I don't know .. grades for example, for my tutors. But, besides tutors, for example my colleagues in the faculty, the other students, or even the member of the lecturers, I don't wanna share that."*

Student19 *"I just want to add a little bit that I agree with him, if (it is shared with) identity just only to share to the personal tutor, I will be fine then, just the personal tutor, not the*

university. If the university want to access this, they should ask me and the personal tutor as well."

Some students mentioned disclosing their information related to their study and work activities as anonymous data because that is enough to help the university analyse their students' behaviour. These students did not want to show their identity because they assumed that the university could still get insight by seeing the pattern of the data to build or develop policies for students.

Student02 *"For me I think, I agree with her (Student04) about sharing anonymously, you know, just to make it easier so, I don't want to share it identifiable and university can still map the users. I think, it's okay just to share like the student gender or maybe the major, or age, so that the university can map the data. Like all student whose age around 20-30 usually spend their activities by this this this. But they don't know about the name to as a person"*

Student09 *"I think just the statistic like for the university; I don't really want them to know. I mean if this is the purpose like the semi-automatic, or something about it, I don't want them to know about my private life because work and private life is like two separate things. Like, I don't really, I'm not be comfortable they are knowing where I go, unless I give the permission to know where I go."*

Student13 *"I would say anonymously as well, because people may take an advantage of using or utilizing the information to justify one person."*

Student15 *"I think, I agree to share it anonymously, because the information is not about, is private, I say, to be shared publicly. And I think, the thing that you asked or explain earlier, on kinds of things that can be provided in the apps is also a very general information in some extent. So, I think it is not necessary to go with our identity on it because it is also general information, like how many times student spend in the library, how many times students attending kinds of specific seminars for example. So, I think it is considered general, so, it is, I don't think showing our identity is gonna worth to the information itself."*

Student19 *"I would like to be for anonymously because to share the identity, it can influence the subjectivity and objectivity of the itself, also for the personal tutor or the university. I mean, why I prefer to be anonymously because it related to the insecurity. So, I think it would be like anonymous, I would become freer to share what I think. That's it."*

Other students revealed their reasons for preferring to keep their information to themselves and their objections to disclosing theirs to others unless it is a mandatory rule to share with tutor or university. These students pointed out that the main reason is privacy and anxiety about sharing the information with others.

Student01 *"So, for me, I actually don't want to share. Basically I don't want to share my information if there's no urgent situation, unless I need a help, or I need the personal .. like, maybe in the case I have like several issues with my psychological thing and someone from the university wants to help me by tracking all of my activities, in a several days. But if the university just want to know my activity pattern regarding to the policy making, I am prefer not to share my information. Because .. yeah I know, it's privacy."*

Student03 *"I also prefer not to share my data because I think it is also privacy and .. unless it is mandatory, mandatory for personal purpose in the course or asked by personal tutor itself, I may share it only with personal tutor. But I think if it is not mandatory, and for any purpose I would not share my data, because I need to keep it by myself."*

Student04 *"I don't want to show it to everyone, unless I have a problem then it is based on my willingness to tell it to others or I need to my supervisor if I think okay I need to talk to them otherwise I just keep it for mine."*

Student06 *"yeah, the same because when it comes about your name and your identity and other students know it, it may cause a kind of anxiety. For me, we can compare to others, it's not good. I mean, we are going for health, healthy competition at school. So, yeah, I don't think that works."*

5.2.5. Theme 3: Gamification

Gamification is designing game-related experiences to encourage users' engagement and their desire to participate (Deterding, 2012). Therefore, gamification becomes the design strategy that use game elements, such as: points, badges or rewards (Wanick and Bui, 2019). Arce and Valdivia (2020) reported that gamification includes the process of making activities more like a game. This means applying the strategies of game-design in a non-game context (Viberg, et al., 2020). The purpose is to improve motivation for targeted behaviours and to encourages the users to use the app again and again.

In this group discussions we asked the students' opinion regarding a gamification scenario that may improve their motivation and engagement to use the time management app.

Students outlined their opinions about the potential use of gamification and their considerations about the design of the gamification scenario.

In our group discussions, students pointed out that gamification is beneficial in increasing users' engagement. By using a gamification scenario such as collecting badges and comparing badges to peers, we may encourage the students to use the application more often.

Student10 *"it will make the users more enthusiast in using the app itself. So, yeah"*

Student15 *"I think it's good to put point of the badges of the app, because satisfaction may deal to psychological things. So, maybe it is not for money or for earn some rewards or discount or anything, but it gives you psychologically satisfaction with it. So, maybe let's to make your study more fun and avoid burden. And also, you can compete with others in a fun way, like .. you are not thinking the study essay very stressful thing because you have your app that can make your study more fun."*

Student19 *"I think it is like self-satisfaction for having a various sticker and you can change it depends on app. Because, I think like for the sticker itself, even though it just like small thing, but sometimes it just like, how to say, like .. people may join apps, because for example like ways they put sticker, and I think Path (apps in iOS) use the sticker as well. For the sticker itself, we can get it for free or get more sticker based on our activities or our performance."*

Student20 *"I am a kind of person who love the layout of apps and I love to see a lot of badges in my apps because it's a personal satisfaction for me and it is a bit cute for me, I don't know. But, personally, it motivates me to get a point if I achieve the target or I unlocked the badges. That's it."*

However, designing the gamification scenario and rewards to engage and attract targeted users to the app must be done carefully. Suppose the gamification scenario caused the users to have too strong motivation to collect badges or rewards? It may cause the users to be addicted to using the app and therefore deviate from its original purpose. Students might even try to manipulate the data, which is contrary to the purpose of self-reflection.

Student01 *"I know it is interesting, but sometimes it's quite addictive, so you are triggered to use the app again and again and again. And at the end you're just focusing all of your activities because of the app, not to your actual purpose of doing that kind of activity."*

Student02 *"I just realize about the rewards like changing with coupons and discount. I think back to the 1st problem I said earlier about the error things if I can manipulate the data to get free awards then, so let's use the app. You know, for example, everybody can manipulate the data and get a free coffee by study for 8 hours."*
Student03 *"I mean, it is still can be manipulated. If using badges, it is like we have to study like 3 hours and then, we can just put our phone and then we don't use it and then, we can just sleep, or anything and then we can log it as study. We still can manipulate the data, if it is for study logging."*
Student04 *"I will put my phone at the office then I'll wait until 8 hours"*

As the app's purpose is to help students' self-reflection, students think they do not need to compare their' achievement aspects to be displayed in a rank-basis / leader-board. Students may use digital badges to compare their own performance over time. Some students also mentioned that they want to compare their target plan with actual achievement.
Student03 *"I think, if the badge is also still added to the features then I will not share to the people but I keep it to myself as my personal self-appreciation and self-reward for my study and for my activity for a day."*
Student12 *"... I don't think it is necessary to have the badges or reward or something. Because I do not like something complicated. So, as long as it has a clear comparation with what I have done before and what I have done today and tomorrow, then, that's fine."*
Student14 *"... if I spend my time to study as the way I wanted, it's enough for me then I will get the reward. Mm .. not the reward, just the sign that I have already achieve my target. ...I will get the self-satisfaction from this. So, just to know that I had already achieve my target and that I get high point."*
Student18 *"Well, for me, to be honest like, I don't really see the points or the badges purpose because, but, again because it is for self-reflection, mm .. I think I just like the idea of crossing the target, not really like collecting the points. So, the definition of self-reflection for studying and working is like crossing the goal for me. So, the points or badges is not working for me."*

In our discussions, students also suggested rewards that might be useful in the future. The rewards are not merely monetary, but they coukd be for their printing balance or tickets for university events.
Student01 *"But if there is any real reward like discount or free coffee, I don't mind at all."*

Student06 *"So, what I suggest is, as a design student, I print a lot of papers and I really want to reward myself with printing balance, it will need to top it up like every 3 weeks for me. It will cost a lot, so, it (the rewards) will be beneficial for that (help with the printing cost)."*

Student09 *"More attractive, like it can be just like vouchers or status. We are broke students so like vouchers or that one buy one gets one or discounts. So, if the reward is that attractive, I don't think many of us would like to use this."*

Student13 *"I would suggest rewards, mm .. like type of rewards or probably discount for example. Like, let say in the case of study … discount book at the stationaries because stationaries are so expensive. Mm .. tickets, for example, for academic event for example let say just going to be a TEDx event, and there is going to be free or discounted tickets or trips as what you've mentioned. Entertainments and a lot of things that is going in Newcastle and sports because I just love to watch sports."*

5.2.6. Theme 4: Other features wanted by students

After discussing the mobile app mechanisms, we also asked about the other features that students want from the app and their priority. Mostly students want an online agenda, goal tracking and file storage or notes attachment in activities record. Each feature with relevant excerpts isdiscussed below.

Students mentioned that they want something basic like an online daily journal to store their agenda or schedule. Furthermore, students also mentioned that they want a feature for comparing their target/goal activities with their actual achievements to check their goal progression.

Student01 *"It is like a basic, an ordinary daily journal, but its .. its transferred to my phone"*

Student05 *"So I can record what I have done yesterday, and what I will plan to do today, or in the next few days."*

Student13 *"I would agree with seminars and conference timetable, and if it's possible, it would be great if they have the faculty basic activities that we can see in the app. For example, in the business school, there is going to be a talk from.. let's say a businessman talking about this, and then for me, it's politics, it's going to be, let's say, a group of Max Weber fan will talk about the political economy. So, that kinds of activities will be great if it is provided."*

Student20 *"Study time target. For me I would say that I want to have a target for a week, like 10 hours, for instance. And I wouldn't lost to track, (It's like) my study tracker .. like how much I spend my time to study like on Monday, Tuesday and so on. Because for me personally, it makes me feel more secure, if I can achieve my target."*

Some other students mentioned storage to keep notes or file on such activities. This storage will be beneficial for them in recalling the activities that they have done.

Student16 *"I think it must to have like the type of activities and maybe if you go to meet your supervisor, you can add some notes to the storage. But it is only note, so you can add notes on your.. the meeting, some notes of your meetings, so, you can check again later, like last week, what do I have to do, what do I have to achieve this time, before meeting my supervisor. I think that's all."*

Student19 *"I want to add more like if we can put like a storage feature in the apps itself. Like for example, it is like the categories of study and then you can click. Not just about the feedback, not just about the kinds of activities that we did, but also the storage like .. that after we study then we can put our file it will be great even though now there is a like a Google Drive and there are so many apps, but we can put it quickly."*

5.3. Participants' Screen Design

In this study, we also performed co-design workshops where we invited the students to sketch out the design of the screen they expect. This co-design aimed to discover unique perspectives through collaboration and include students' opinions in essential decisions. The students' presence is essential in this creative process, as the users provide insight into what is valuable to them. Co-design helps designers to confront the realities of students' emotions – be that happiness, joy, anger, or frustration – and the motivations behind their behaviour. This collaborative approach promotes constructive reflection and dialogue where all parties are equal and work together towards a shared goal.

In our co-design workshops, students were asked to design the report screens for the app. These designs demonstrated the features that students expect in a study/work tracker application. There were, in total, 35 screen designs from the participants. Overall, there are four features expected by the students. Each of the features is explained below.

1. Students expect the feature for comparing goals and the achievements for a specific period.

   Both designs in Figure 5.1. and Figure 5.2. showed that students expect information about their planning and target activities. The comparison of plan and target could help students to find out how well they implemented their plan. The information of plan and target may be displayed in a bar chart or a list of information.

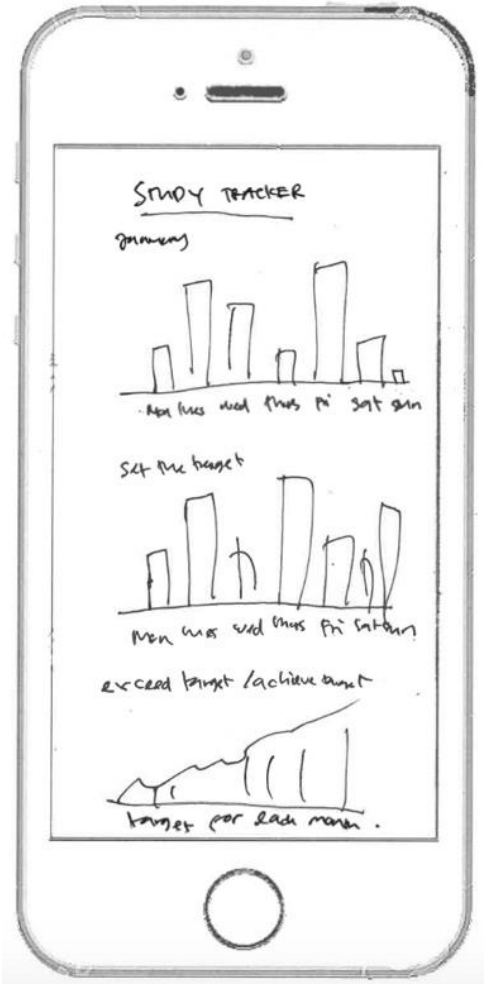


Figure 5.1. Student20 – Master student, F, 26 YO.

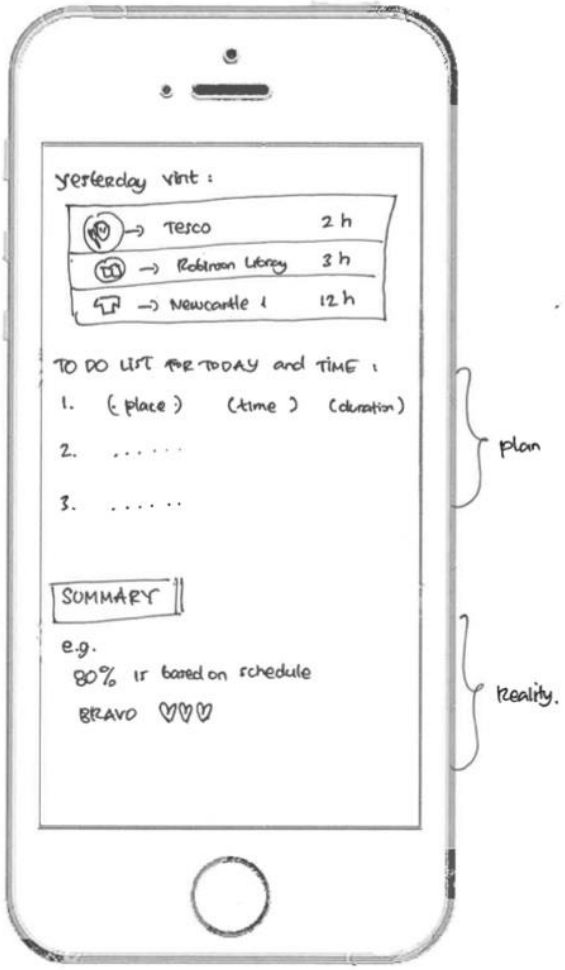


Figure 5.2. Student05 – Master student, F, 35 YO

2. Students expect the feature for comparing the percentage of time spent on certain activities or places visited. That information could help students figure out their overall time spending behaviour to self-reflect and manage their time better to achieve their goals.

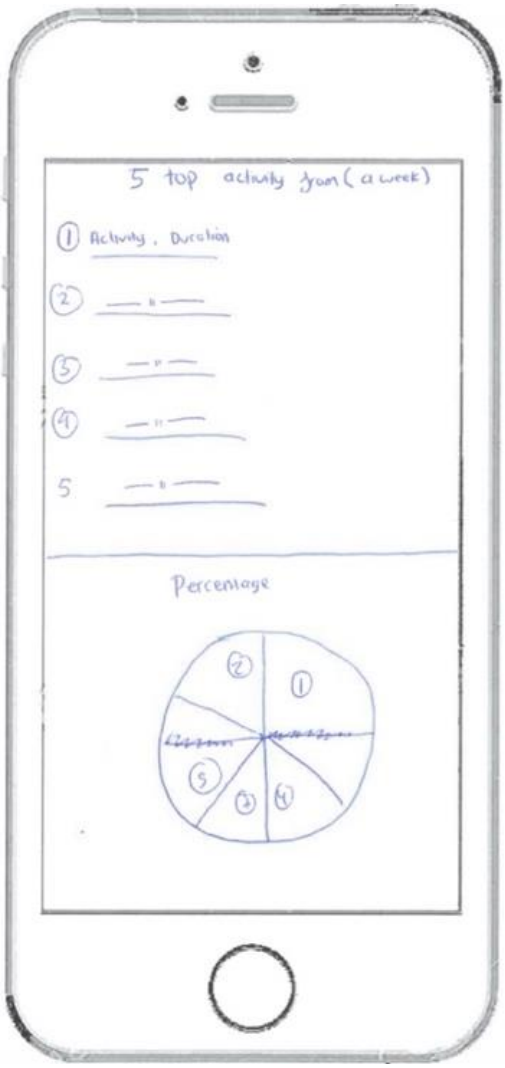


Figure 5.3. Student14 - Master student, F, 24 YO

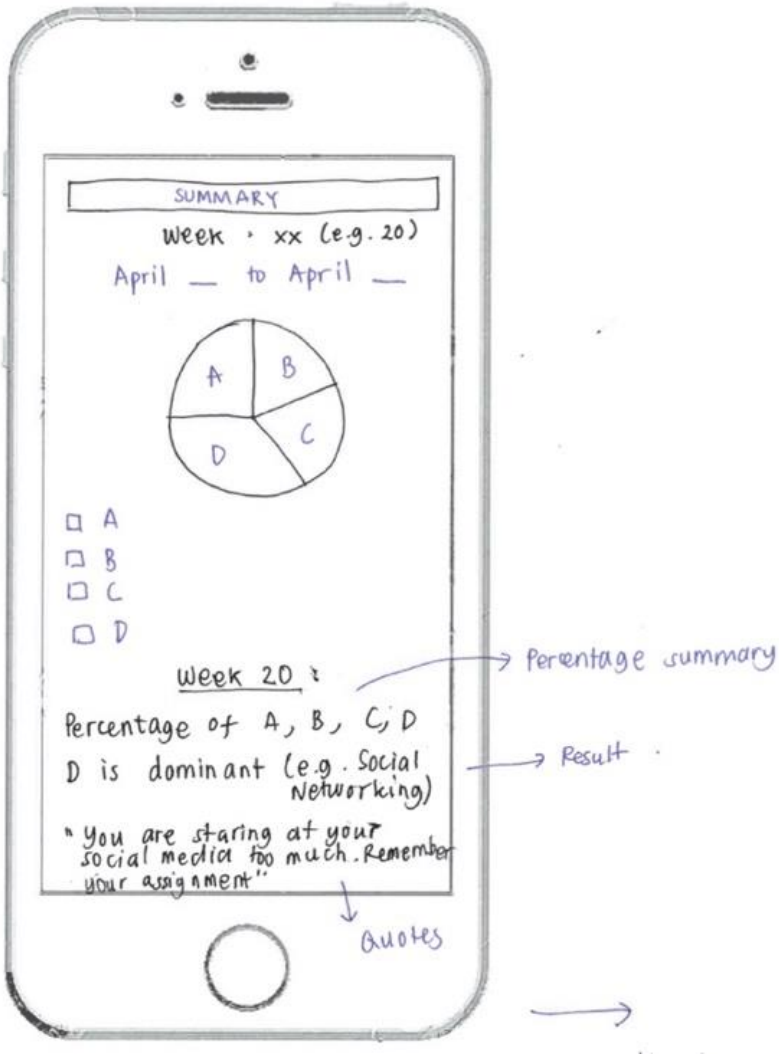


Figure 5.4. Student03 - Master Student, F, 27 YO

Some students prefer to display the percentage of time spent on activities recorded by the app in a pie chart (Figure 5.3 and Figure 5. 4). Alternatively, the information may be displayed in a bar or circle chart (Figure 5.5 and Figure 5.6). The students' design displays show only certain top percentages of time spent on activities (e.g. top 5 activities), giving more high-level information to grasp instead of putting all of the detailed information on one screen.

Furthermore, the students expect to see information about time spent in several different places and the week's completed goals. Some students also expect to be able to compare

their statistics to their peers. Meaning that the students are willing to disclose the information to their peers anonymously.

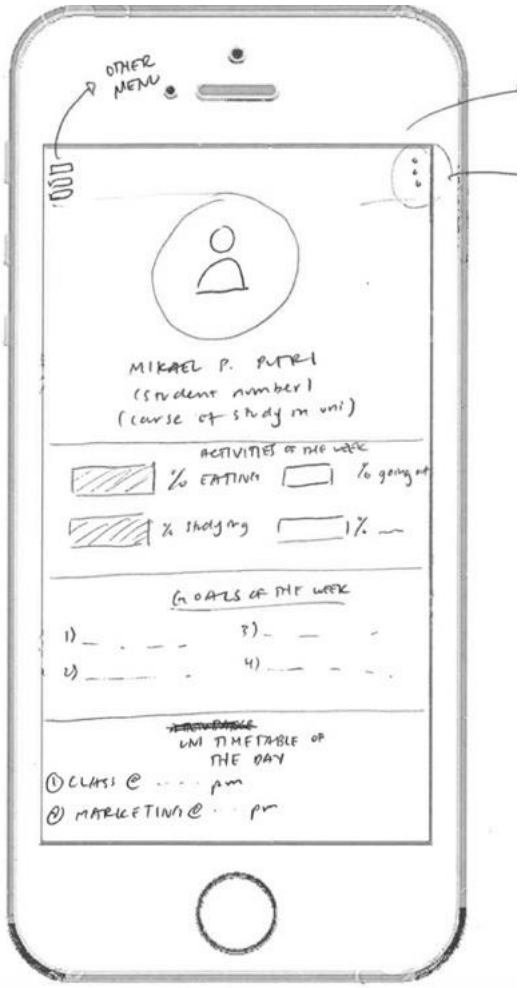


Figure 5.5. Student09 - UG Student, F, 19 YO

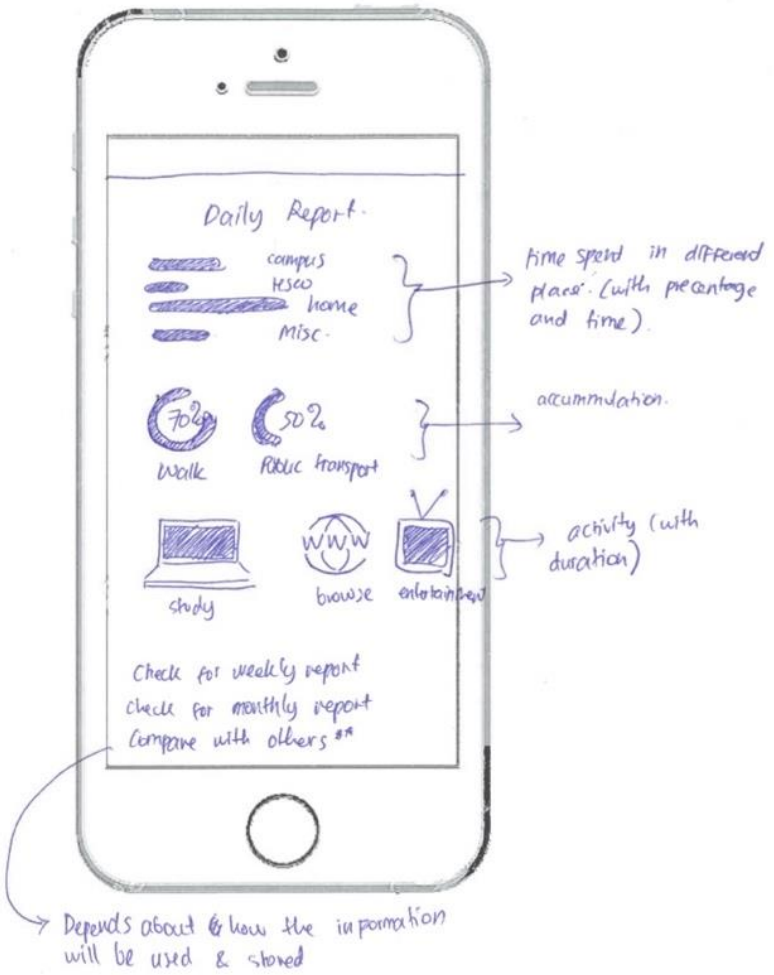


Figure 5.6. Student02 - Master student, F, 25 YO

3. Students expect a feature to display a daily timeline that describes the activities in a day sequentially. This information could help students do daily self-reflection to see where their time goes. Both designs (Figure 5.7 and Figure 5.8) show that the daily timeline's information should include: a date and time selector, time, visited location, and activities. Figure 5.7 shows the earned points of each activity. The points were designated for gamification that the students expect to make this application more fun and engaging.

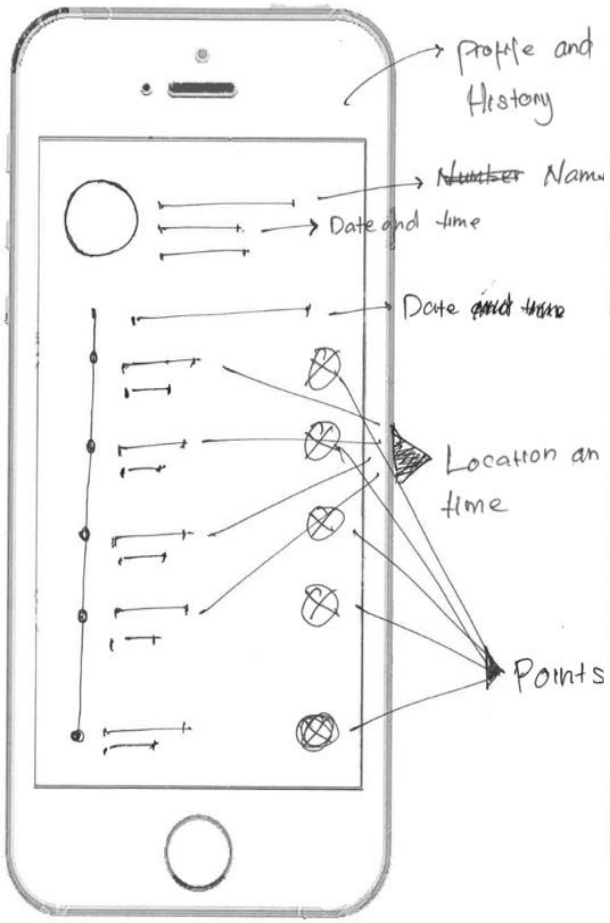


Figure 5.7. Student10 - UG Student, M, 20 YO

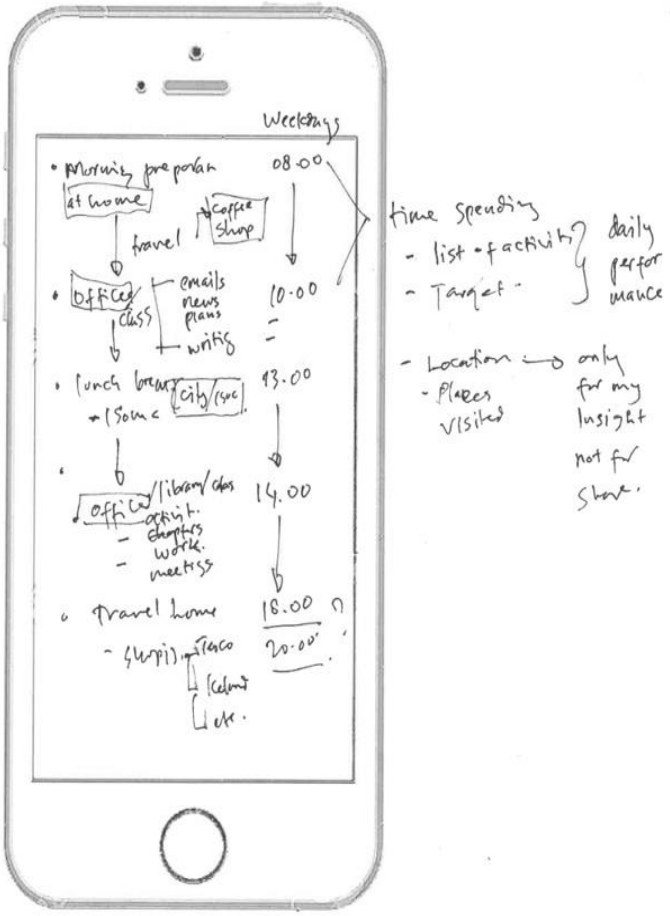


Figure 5.8. Student04 - PhD Student, F, 39 YO

4. Students expect a feature for badges/medals that symbolize the points/score that students get from their completed target (Fig 10 and Fig 11.). Each activity towards completing a goal deserves points. This scenario could help students feel more motivated to achieve their target.

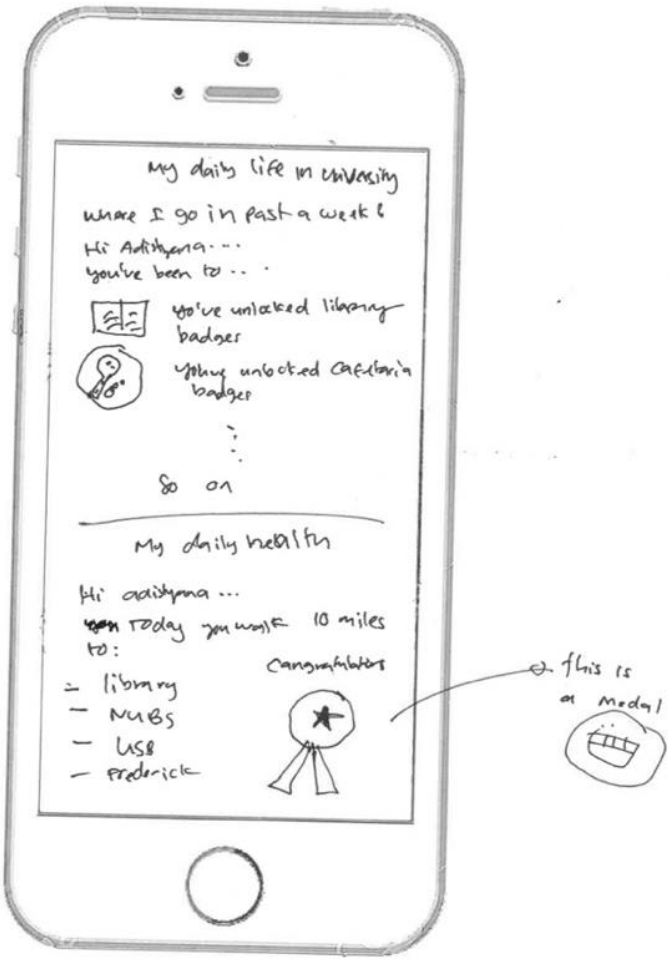


Figure 5.9. Student20 – Master student, F, 26 YO

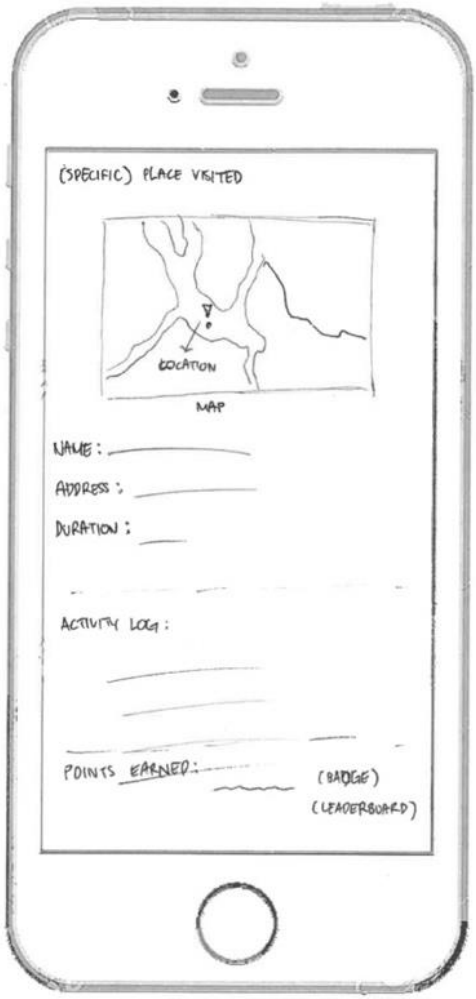


Figure 5.10. Student07 - UG Student Y3, M, 21 YO

5.4. Study Limitations

It should be noted that this research has limitations and constraints. First, the participants in these group discussions are ideally those who already participated in filling out the questionnaire in our previous study. However, some participants have already finished their education at Newcastle University and gone back to their home country. It was challenging to recruit participants in this study that follow all the stages in this study since most of the participants are master students, who only have a one-year programme. To overcome this problem, the participants were then extended using snowball sampling. The chain referral process helped to reach populations that are difficult to sample with cost-efficient and a simple process. However, this sampling technique may cause sampling bias. The initial participants tend to nominate people that they know well and highly possibly share the same traits and characteristics. Therefore, it is possible that the sample in this study is only a small subgroup of the entire population.

Second, the interpretation that this study's participants discuss are not meant to be generalized across all university students. Instead, this study offers preliminary insight into how some university student populations perceived the mobile app to help their self-reflection during their study. The groups were homogenous, based on the participants' educational status and age.

5.5. Discussions

The focus group study brings a new dimension to this research. It offers an understanding of the features and mechanisms that students expect from a mobile app to support their self-reflection regarding their time and goal management in learning activities. Participants should trust the app to record their activities, time, and location, and therefore we need to hear their questions or even doubts about how the app works and how it can be improved. Thus students' opinions can be used in the design considerations for building the proposed app.

As discussed in the previous chapter, the online questionnaire provided answers to how students perceive and expect the data and sharing mechanism inside their self-reflection apps. Before the group discussions, there was no evidence about which data the participants would like or dislike to reveal with others and what features and app mechanism they would

like to have. The focus group discussions enlightened the previous studies' results by offering multiple perspectives on students' opinions and reasoning.

There are four themes which were derived from our guided questions for these group discussions. This sub-chapter discusses the themes and recent literature.

Theme 1: Location tracking

Location-based technologies, such as location-based contextual advertising, mobile phones with GPS capabilities, and navigation systems, are becoming more widespread. Apps that used location-based technologies are widely used for many reasons, including purpose-driven apps which are linked to practical issues, or social-driven apps which are linked to social interaction. A purpose driven app is a platform where people explicitly record their location to use online services (Vgena et al., 2019). An example of a purpose-driven app with location tracking features is BigBurgh[17] where members of the homeless community can report the location of another member who is in need of immediate aid from service providers. Another example is the Uber[18] app where drivers can connects with riders, eaters and restaurants.

A social-driven app is an app which people can use for social orientation, such as feeling part of the online community or expressing oneself. (Vgena et al., 2019). The motivation for users' sharing location is mainly the need for social connection, but also for economic benefits, e.g. to get a lower price, extra discount, or to get higher position. Some examples of social-driven apps with location sharing features are: Facebook where users may share their check-ins and reviews, Yelp and Foursquare where users may share reviews on services and venues (Singh et al., 2020).

How users would like to disclose their representation may combine their identity and geolocation data. The use of both identity and geolocation may represents users online personas. For example, users tend to disclose their geolocation that shows they are located in a university not only providing geospatial context but also enabling their viewers to draw their inferences about their academic status (Jain et al., 2021). Hollenbough et al. (2021)

[17] www.bigburgh.com
[18] www.uber.com

reported that along with self-disclosures, social media users share pictures and location check-ins to influence impressions from others.

Although location-tracking technology can make people's lives more convenient, it brings privacy concerns related to the storage, transmission, and sharing of users' locations and identities (Tsai et al., 2009). Chowdury et al. (2020) reported that location or proximity data associated with personal data might be harmful, which may diminish the users' trust when using the apps.

During the focus group session, participants discussed how the app should record their location. Some of the participants wanted their position to be recorded continuously. The reasons behind this were varied, including simplicity, so they do not need to check the app every time. The app may be set to ask the users every time before recording their visited place. However, some students found that this was impractical. This finding is consistent with that of (Gruteser and Liu, 2004) who reported that manually approving every location tracking request could be cumbersome.

Furthermore, the students that wanted the continuous location tracking features mentioned that they wanted to get a precise picture of their daily statistics, where they spend their time in a day. This finding broadly supports the work of other studies in the "Quantified Self" (QS) research field. Using QS technologies, people nowadays who need to improve their performance or habit can see their daily stats to see their progression over time. Lee et al. (2019) reported that self-reporting wearable technologies have potential benefits in educational settings because they produce genuine and granular data about activities and experiences. Students may used journaling of their study activities to engage in self-reflection. Kampen (2020) reported that this concept can give students insight into their time-management behaviour and may reduce academic procrastination. Similarly, some participants in our study also wanted to see the places they visited by using the tracking technology to have insights regarding where they spend time every day.

Other participants in our group discussions also pointed out their preference to have semi-automatic location tracking, where they can grant the app permission to record their visited place or not. This result may be explained by the fact that they want to have flexibility because their privacy desire might contextualise or depend on the situation. Research by

Gruteser and Liu (2004) reported that individuals' desired privacy levels could be situation-dependent regarding location tracking technology. For example, in a few situations – when users enter certain sensitive areas – they want the information about their location to remain private.

The other reason why students want to have semi-automatic location tracking is regarding the tracker's accuracy. Low accuracy and poor real-time performance are the two main shortcomings of location-based technology (Baalsrud Hauge et al., 2021). Chowdury et al. (2020) pointed out that the location-based service data may rely on these technologies: Global Positioning System (GPS), Bluetooth, Wifi, or cellular networks. These technologies nowadays still cannot distinguish the location of people separated by a wall or are on two different floors of a building. Therefore, it makes sense if some participants in our study doubt location-tracking accuracy, so they want to check the visited place detected by the app before saving it as a record in their daily journal.

Although there is doubt about its accuracy, inevitably, more users accept location-tracking technology (Yong et al., 2019; Shubina et al., 2020). Location-tracking technology helps humans in many aspects. For example, it may detect the users' physical activity and position in health and fitness apps, such as how far they have run or cycled, or where and the path they took. However, it cannot be denied that the information regarding an individual's location is susceptible to misuse. Since the proposed app employs users' location data, the user preference regarding revealing their location with others or keeping it only for self-reflection needs to be studied further.

To sum up, some students wanted to have automatic location tracking, semi-automatic location tracking and even no location tracking at all. Based on this condition, the first design consideration is to best present flexibility of location tracking features to students. Some of the assumptions for this design consideration are:

1. The flexibility of selecting location tracking mode is needed since the students' preference could be situation-dependent.
2. Since it relates to the privacy issue, the tracking mode selection should be clear and straightforward to help students become aware of the options.

Theme 2: Data sharing with others

In general, people may engage with selective self-presentation by disclose certain aspects of themselves while downplaying others (Goffman, 1959). Self-disclosure, the revelation of personal information, is a core component of self-presentation (Hollenbough, 2021). People may develop private or public images through self-disclosure. Research has found that people may share pictures and location check-ins in social media with the aim of developing their public image (Barbovschi et al., 2018; Vgena et al., 2022).

The desire of users to disclose their personal data and share it only with their circle when using certain apps vary widely. Some tracker applications, e.g. FourSquare[19], limit the personal data disclosure in user's collaborations to only share high-level statistics or achievements. Can and Alatas (2019) reported that people may disclose their locations to reach a wider circle. Fitness tracker apps, such as Fitbit, use location tracking and let their users share data with their friends (e.g. in a competition). The aim is to get extra encouragement or peer support and to motivate users' behaviour change (Mazur-Stommen and Farley, 2020).

Furthermore, Külcü and Henkoğlu (2014) revealed that concern for privacy loss is a significant barrier to the self-disclosure of personal information. One may disclose their information and lessen their privacy concerns to get the desired benefits. For example, one may receive monetary rewards, such as a cash bonus, coupons or discounts as compensation for revealing personal information in online transactions (Gutierrez et al., 2019). Social rewards, such as pleasure and relationship development, also may motivate individuals to self-disclosure of their personal information. In online social networks, such as Facebook, users gain social benefits by revealing their data, which is also exposed to a loss of privacy (Jozani et al., 2020). They may disclose the information if the benefits outweigh the cost.

Depending on how individuals wish to represent themselves, they may link their identity and geographical data. Both identity and geolocation may be used to reflect the online personas of people. Users frequently reveal their geolocation services, for instance, indicating that they are at a university, allowing viewers to not only get geographical

[19] Quantify Yourself: (Mostly) Free Tools & Strategies to Track (Almost) Every Area of Your Life. Retrieved February 29, 2020 from https://doist.com/blog/quantified-self-apps

context but also speculate about their academic reputation (Jain et al., 2021). In addition to self-disclosures, Hollenbough et al. (2021) found that social media users publish photographs and location check-ins to affect others' perceptions.

In our group discussions, the possibility of users sharing their data to get benefits such as getting peer or community support also have been investigated. However, students seemed uncomfortable about disclosing identifiable data with peers: they would like to share their data anonymously to their peers. Some students also prefer to disclose their identifiable data to their personal tutor or university. The benefits they might get by sharing their data is to get personal feedback from a personal tutor or to help the university measure its students' behaviour to supporting policymaking. The participants also indicated the information they are willing to disclose such as time, duration, and name of the activity.

Most of the participants prefer the anonymous sharing of data with tutors and university. They feel that the way they share information should be aligned with the purpose. When the university needs to analyse students behaviour to develop strategies or policies, seeing the pattern of the students' anonymous data may be enough. The anonymity separates the online users' identity with their offline representation (Hollenbough, 2021). DeVito et al. (2017) reveal a connection between anonymity and self-presentation performance. The higher the degree of anonymity of online users, the fewer constraints on offline users' self-presentation.

Moreover, the participants were also concerned about who might see and have access to the location data since they feel this is sensitive and private information. Boutsis and Kalogeraki (2018) reported that location data comprises confidential user information. The nature of the location information enables an adversary to expose a considerable amount of information per user. Hence, when untrusted parties use the data, it can lead to inevitable consequences, ranging from user profiling for advertising purposes to real-world crimes such as stalking or even robberies.

Based on this condition, the second design consideration is an aspect related to the data-sharing mechanism. Some of the assumptions for this design consideration are:

1. The data of students' activities and duration are appropriate to be shown to personal tutor/university, unlike location data which is considered more private.

2. The students feel that the data of students' activities and its duration could be shared as anonymous information (in statistics) to help the university get insight into their students' behaviour.

Theme 3: Gamification

Gamification's guiding idea is to use game design elements in non-game contexts, products, and services to motivate desired behaviours (Deterding, 2012). Rewards that attract gamification users may form a powerful social psychological process such as self-efficacy, group identification, and social approval. These compensations drive most of the user engagement in today's social apps, primarily through the power of good feelings. Hence, gamification is a motivational design problem that can be best solved with design thinking and design processes.

However, people differ in the degree of what they want to show regarding their social network status. The propriety of any given reward will vary by context. For example, what is appropriate in the context of a sports-fan site may not be suitable in the context of an academic-discussions forum. This study investigated how students perceived the possibility of a gamification design applied to the proposed self-reflection app.

Our participants commented on the gamification scenario that will be used in the proposed app. The participants agree that satisfaction may deal with social-psychological things such as getting digital badges or points. Nevertheless, there is also a concern that gamification may mislead users from the self-reflection purpose because of its addictive effects. Collecting badges can be an exciting activity and motivate users to collect more and more badges, which later they may forget the actual purpose of using the app.

Moreover, users may manipulate the system to get more badges. Users may intentionally cheat the system although they are aware of their actual goals. For example, a fitness app user identifies an opportunity for receiving more fitness points for an exercise than it is worth, or even for getting these points without doing any activity at all. When individuals use these tricks, they will progress in the app but will not get any fitter in real life. Gaming the system's rules can be experienced as a worthwhile activity and can become an intrinsic motivation in itself (Xu et al., 2021). However, if it becomes the primary motivation to use the app, obviously gamification loses its means to initiate positive behaviour change in the

real world. Therefore, gamification's goal or mission should be clear, so the users get the right direction and not become addicted or start to game the system.

Our intention in involving the gamification concept, including a rewards and leader-board, is to increase the users' engagement in using the app. During the discussions, participants seemed happy with digital badges or scores to see their performance and progression over time. Including several visualizations of student performance, digital badges were found to help inform students about their behaviour and progress (Sousa-Vieira et al., 2016). This information may serve as a formative assessment in a learning setting that helps student self-reflection. Thus, gamification may improve the visibility, comparability, and immediacy of performance information (Gerdenitsch et al., 2020). In other words, digital badges may help users to have insight into how they are performing, so they can reflect and consider whether they need to change their behaviour or not.

Furthermore, the participants also commented on their feelings regarding comparing their performance with others. Almost all participants indicated they disliked being ranked in such a leader-board. The leader-board idea in a self-reflection app makes them feel more insecure and anxious. The participants seemed to prefer keeping information about their performance for their reflection only to see their behaviour or progression over time. Since the goal is to improve students' performance in time management, comparing with other participants would not increase motivation since they might have different goals and priorities. Comparing their achievements in such a leader-board may harm their intrinsic motivation because it may cause students to feel less competent or not in control.

This result further supports the ideas of cognitive evaluation theory that when a reward is seen as a control, it may cause one to feel less capable, less confident, or not in control, thus possibly decrease intrinsic motivation (Ryan and Deci, 2020). Participants use our app presumably of their own free will with intent to help their self-reflection process. When the information in such a leader board is imposed, they may feel forced and constrained. Being forced to do something can decrease intrinsic motivation (Kyewski and Krämer, 2018). Fong et al., (2019) also reported that in their study, additional rewards that are interpreted as control might cause the students to feel less satisfied with the course, less confident and have less motivation to engage with the material. Therefore, we use digital badges to

provide information or feedback on user performance, but we avoid building a leader-board feature since it may harm user motivation.

Based on the information above, the third design consideration is related to increasing the students' motivation to use the app. Some of the assumptions for this design consideration are:

1. Avoid using a leader-board feature to compare the students' personal stats with their peers. Instead, using a graphic/chart to compare students' stats with the average peer stats will be more helpful.
2. Since students have their own goal/target, the goal achievement chart is essential for knowing their progression towards the goal.

Theme 4: Features expected

The participants came to the focus group session with a preconception about automated technologies imposed to track their activities. Their initial thought was concerned with data privacy, being controlled, and the monetary benefit they may get by using the app. However, after discussions, their final thought demonstrates a positive attitude towards using the app to support their self-reflection and see how they perform over time. As they understood more, they became more interested. Changes in their opinion occurred at several points. For instance, after discussing the purposes and mechanisms used by the proposed app, participants mentioned rewards related to personal satisfaction, not merely monetary rewards.

The participants also described features they expected, such as schedule management, file storage in the activity description and goal tracker. Furthermore, through the participants' screen design, there are more expected features: comparing goal and actual activities, comparing time spent doing certain activities or visited places in specific periods, daily timeline, and badges/medal/score.

According to Wacjman (2019), scheduling is essential to the contemporary practice of time management. It encourages us to engage in fewer "time-wasting" activities. The primary use of a calendar as a schedule emphasizes the highly rationalized temporal order in which time is seen as a limited resource that must be used as effectively as possible. Thus, calendars actualize a historically and culturally unique method of calculating and ordering

time. The gamification principles revealed by Eisingerich et al. (2019) include social contact, a sense of control, goals, progress monitoring, rewards, and prompts. These concepts foster hope and thereby raise users' engagement with the apps. Like our research participants, students' time management apps are expected to have functions like goal and schedule management.

To conclude this discussions, all design considerations for each theme that is obtained from this stage of study is summarised on Table 5.3.

Theme	Design considerations
Location Tracking	1. The flexibility of selecting location tracking mode is needed since the students' preference could be situation-dependent. 2. Since it relates to the privacy issue, the tracking mode selection should be clear and straightforward to help students become aware of the options.
Data sharing with others	1. The data of students' activities and duration are appropriate to be shown to personal tutor/university, unlike location data which is considered more private. 2. The students feel that the data of students' activities and its duration could be shared as anonymous information (in statistics) to help the university get insight into their students' behaviour.
Gamification	1. Avoid using a leader-board feature to compare the students' personal stats with their peers. Instead, using a graphic/chart to compare students' stats with the average peer stats will be more helpful. 2. Since students have their own goal/target, the goal achievement chart is essential for knowing their progression towards the goal.
Other expected features	- Schedule management - File storage in the activity description and goal tracker - Comparison target and actual activities

	- Comparison time spent doing certain activities or visited places in specific periods - Daily timeline - Badges/medal/score as gamification aspect

Table 5.3 Summary of design consideration for each theme

Chapter 6. Usability Testing of Application Prototype

This chapter aims to discover design problems and insights from users' views using the prototype. Prototype creation is an essential step in software product development. Prototypes provide early-stage opportunities to check the scenario design and user interface before coding the solution. Performing user tests with prototypes provides valuable feedback that designers can use early in the design process to avoid costly mistakes.

Based on findings from the previous chapter, the user interface for several task scenarios were designed. In each task scenario, the context was provided to help the participants engage with the interface and pretend to perform the tasks as if they were in their natural environment. In this study, users reviewed the interface concurrently. They used "think aloud" while performing task scenarios. The students' voices in this study are used to find usability issues and make guidelines to improve the app's design.

6.1. Usability Testing

6.1.1. Participants

This usability evaluation aims to discover design problems and insights from users' views. Nielsen (2012) acknowledged that four or five users interviewed in usability testing could tell if something was problematic. According to Pendell and Bowman (2012), five to eight participants are usually required for an effective usability test. Likewise, Az-Zahra et al. (2019) suggested that five representative users were enough to measure effectiveness, efficiency, learnability, memorability and errors during a usability test.

In this study, six participants were selected from the previous research stage to ensure the participants engaged with the app flow. Table 6.1 shows the participants' demographic information.

Participants	Degree Level	Gender	Age range	Self-tracking experience
Student01	Master Student	Female	24-29	Uses Apple Health to count steps
Student02	Master Student	Female	24-29	KnowS the app, but does not use it at all
Student03	Master Student	Female	>=30	UseS Instagram screen time to control social media addiction
Student04	Undergraduate Student	Female	18-23	Uses Apple Health to count steps
Student05	Undergraduate Student	Female	18-23	Uses a location tracking app to count steps and see daily walking distance
Student06	Doctoral Student	Female	>=30	Uses a default phone app to see a walking/jogging tracking map and count steps
Student07	Doctoral Student	Female	>=30	Knows the default health app on her phone but just uses it to check daily steps.

Table 6.1 Participants' demographic

6.1.2. Prototype Design

This stage aims to find design problems and users' views after interacting with the app prototype. There are many tools for developing application prototypes, such as Figma, Balsamiq, Adobe XD and Sketch (Li et al., 2021). Figliolia et al. (2020) suggested using Adobe XD for user testing because of its advantages over other prototyping tools. Adobe XD is a software prototyping tool helping UI designers to define layout views and more detailed appearances. Moreover, Adobe XD allows the design to be interactive and connected with the navigation structure (Schwarz, 2017). Figliolia et al. (2020) reported that Adobe XD is the most accessible tool to get started, as no programming is needed. Furthermore, the Adobe XD design can be stored in the cloud, which allows rapid user testing and simplifies the sharing process between designers and testers.

The prototype design for this study was built using Adobe XD for the reasons mentioned above. It was interactive, and all menus and buttons were clickable and led users to different pages.

6.1.3. Testing Scenario

This moderated remote usability testing was done with real-time participants who have been involved in previous group discussions. Moderated remote usability testing was chosen, as the test participant and the organiser of this testing were at different physical locations. Although in the same area in Newcastle, the test could not be done at the same location due to the Covid-19 outbreak restrictions. The significant advantage of remote usability testing is that it is not expensive. Also, it is easy to collaborate with users from different geographical regions. In this remote usability testing session, the users were given a set of tasks and instructions on how to perform them.

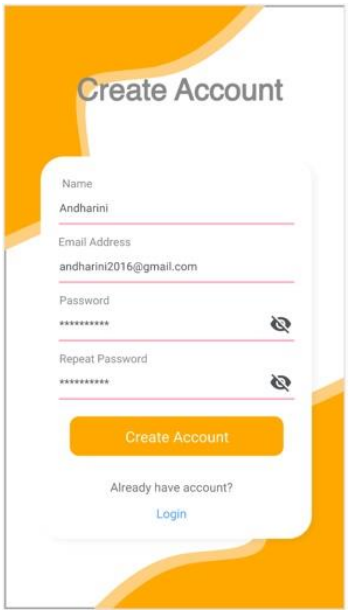
Students were asked to do the tasks and review each of them. All proper instructions were provided at the beginning of the test as brief guidelines (Appendix C). As it was a remote test, a web link was also provided to review the prototype. There were eight tasks that participants had to check. While solving the tasks, participants were asked to speak aloud about what they were thinking, doing, and why they were doing it (think-aloud protocol). Participants' comments and their screen share were recorded using the Zoom application. In a retrospective interview that followed immediately, they were questioned about the tasks and the usability of the software interface.

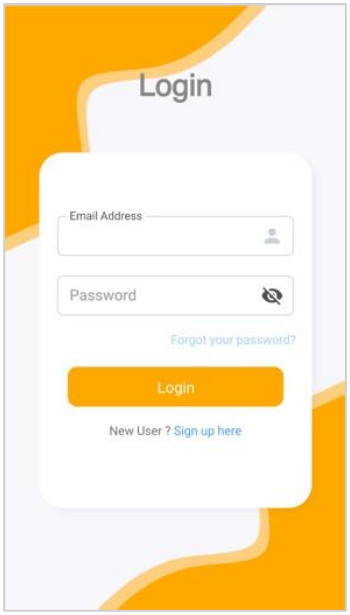
After completing the tasks, users were asked post-task questions to prioritise the features of the mobile application. This remote usability testing took place for around 55 - 75 minutes online, including technical checks, testing instructions, performing each task and answering the post-questionnaire. The recorded audio was then transcribed and put in NVivo12 for further analysis. The scripts were then highlighted for each task. Issues detected from the interview were then identified and categorised.

At first, the activity tracking tasks were ordered as the beginning task since these tasks were considered the main feature of this app. Student01, student02, and student03 did the tasks using this order. However, it seems the task-sorting based on the app's main features made the participants get confused with the design flow. Therefore, the order of the tasks was

changed. The tasks were sorted based on the activity flow for the subsequent participants, reflecting how the participants were supposed to use the app properly from scratch. This plot helps the participants understand the design better and minimises their confusion. Those eight tasks were:

Task 1. User Registration



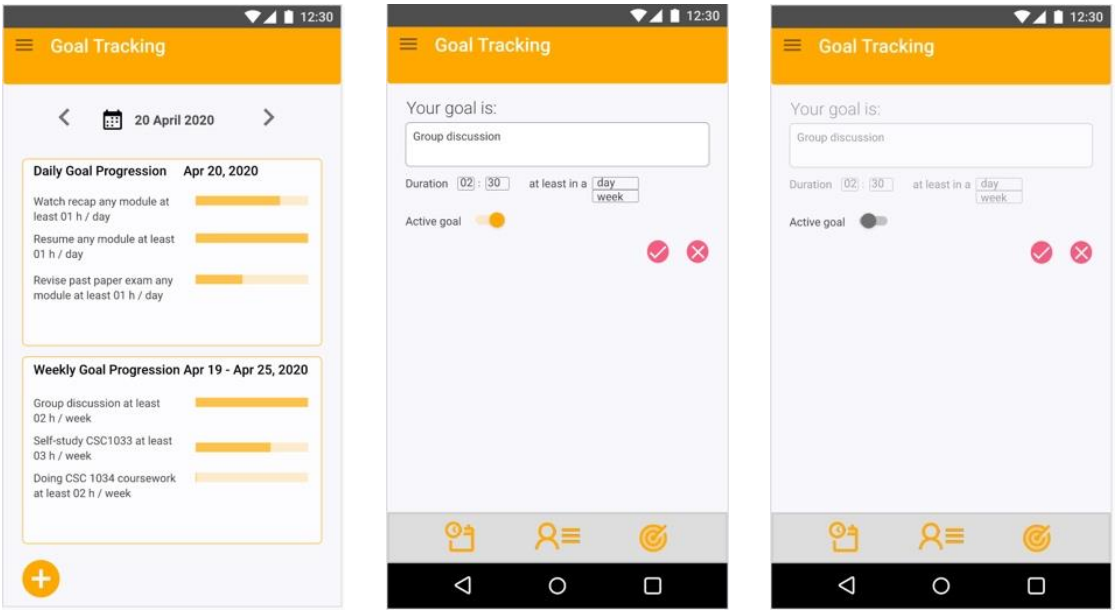


Create Account page *Login page*

Figure 6.1. User registration scenario

These pages were intended to handle the user registration scenario (Figure 6.1). The fields for user registration are as commonly used (Name, Email Address, Password). Before logging in, a user needs to register an account. In this Task 1, users were asked to review the user registration and login process.

Task 2. Goal Management

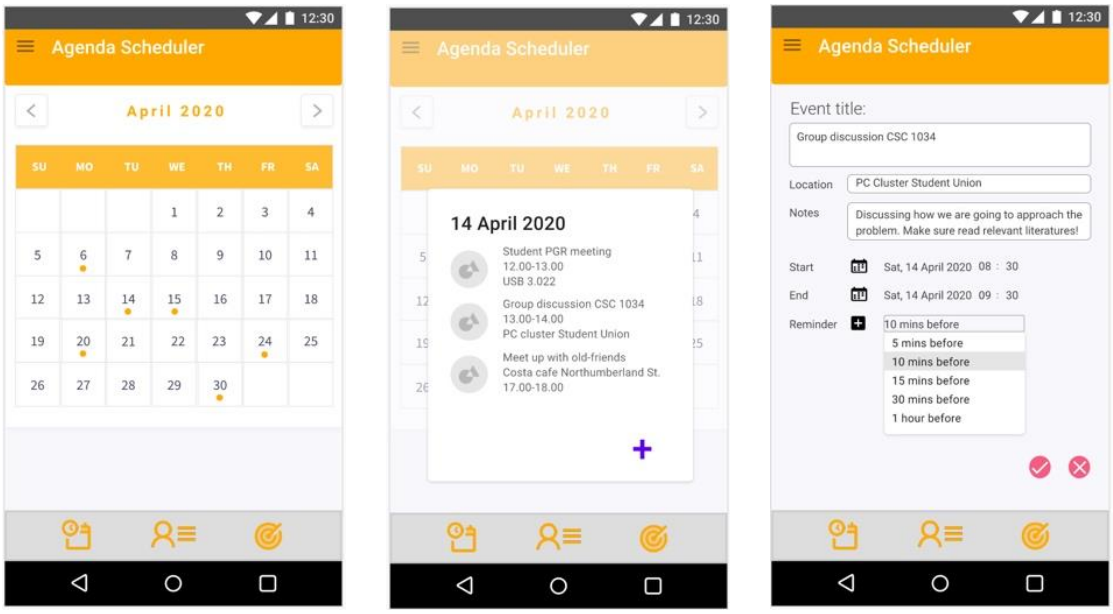


View goal progression *Add a goal* *Edit a goal*

Figure 6.2 Goal Management scenario

In the Goal Management scenario (Figure 6.2), users may view their goal progression using a filled bar chart diagram. To add a new target/goal, the user needs to click on the button and fill in the detail in the form. The data fields used in goal management included the goal name and duration in a specific period (daily or weekly). In this Task 2, users were asked to review the pages of goal progression.

Task 3. Schedule Management

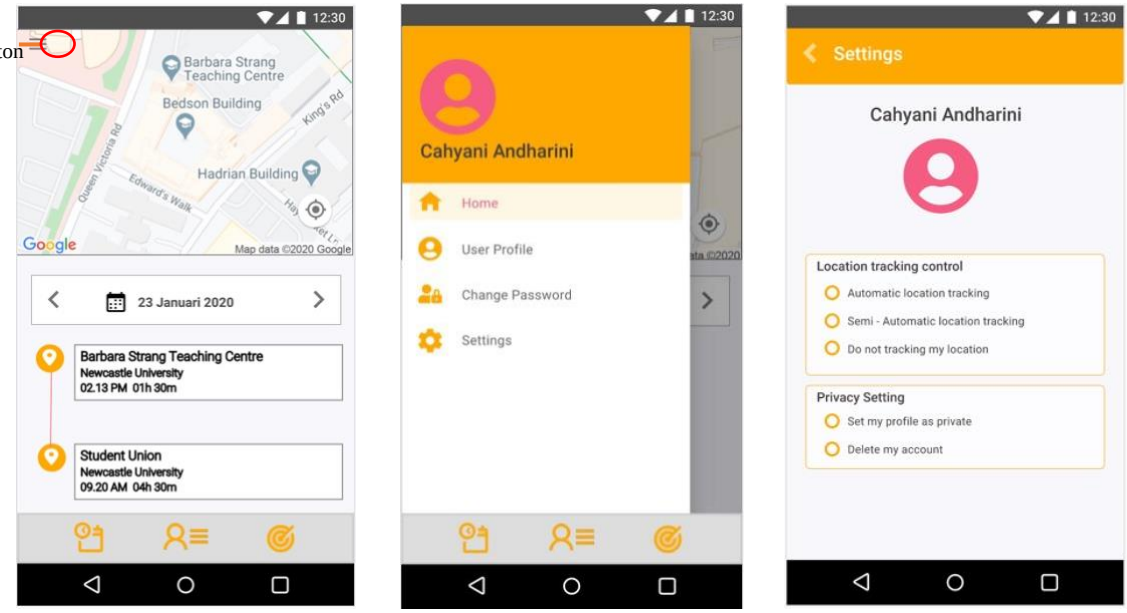


Schedule in Calendar view *Schedule in Daily View* *Add a schedule*

Figure 6.3. Schedule Management scenario

Users may record their schedules and set reminders in the Schedule Management scenario (Figure 6.3). Users may see their agenda in the daily view of a calendar. In this Task 3, users were asked to review the activity of adding a new schedule on a specific date and setting reminders.

Task 4. Settings menu

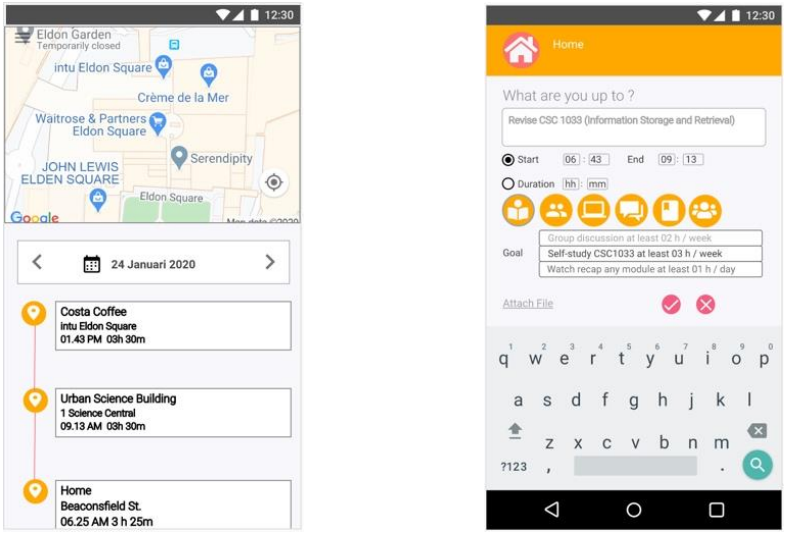


Menu button *List Menu* *Settings page*

Figure 6.4. Settings Management scenario

In the Settings menu scenario (Figure 6.4), the user can set the location tracking mode, to use automatic location tracking, semi-automatic location tracking or no location tracking. Task 4 asked users to review the location tracking mode setting flow, starting from the login process.

Task 5. Automatic location tracking mode

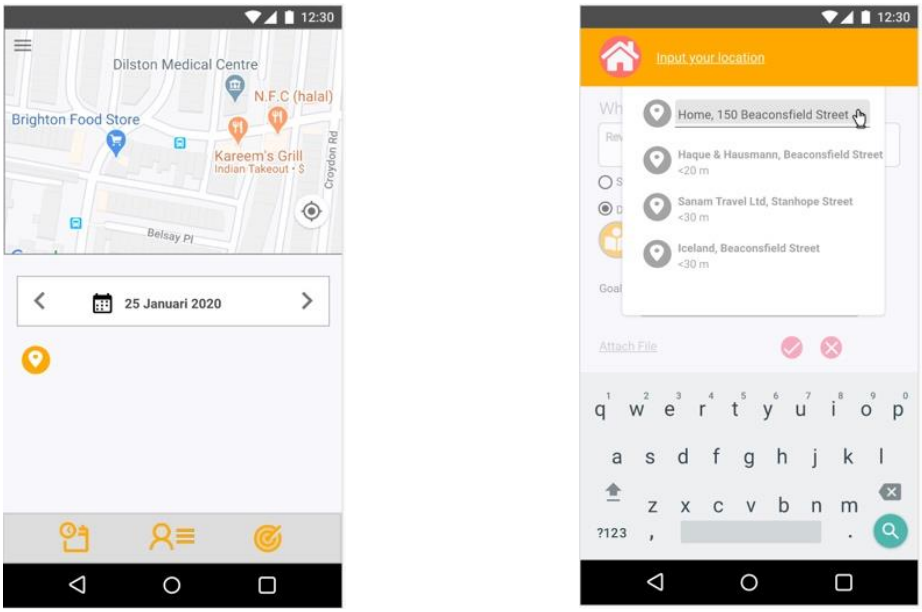


Daily timeline *Activity details*

Figure 6.5. Automatic location tracking mode

Figure 6.6 shows the page designed for recording the activity details in automatic location tracking mode. The places visited will be added automatically by the app. This option is provided for users who want to know all their visited locations in a daily timeline, which is automatically recorded. After a location is logged, users may record their activity details at the specified location. These include the activity name, time, type of activity, and the activity goal. Task 5 asked users to review the scenario of recording activity details on a specific date in automatic location tracking mode.

Task 6. No location tracking mode

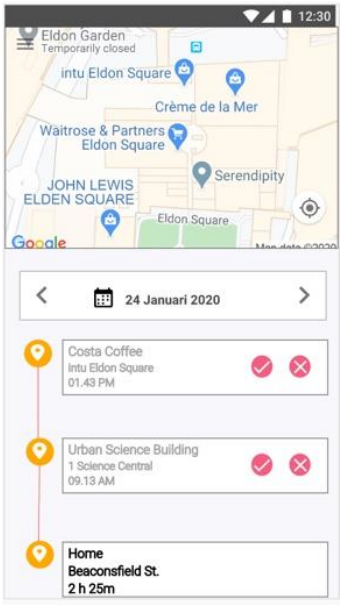


Empty daily timeline *Manually input location*

Figure 6.6. No location tracking mode

There is no significant difference in layout design between the *No location tracking* and the *Automatic location tracking*. Both designs consisted of a map, date, date selector, and list of locations in a daily timeline. The difference between them is the mechanism to record a location. To add a location in manual location tracking mode (Figure 6.6), the users need to click on the location icon ( ) and add the location manually on the Activity details page. Task 6 asked users to review the scenario of recording activity details on a specific date in no location tracking mode.

Task 7. Semi-automatic location tracking mode



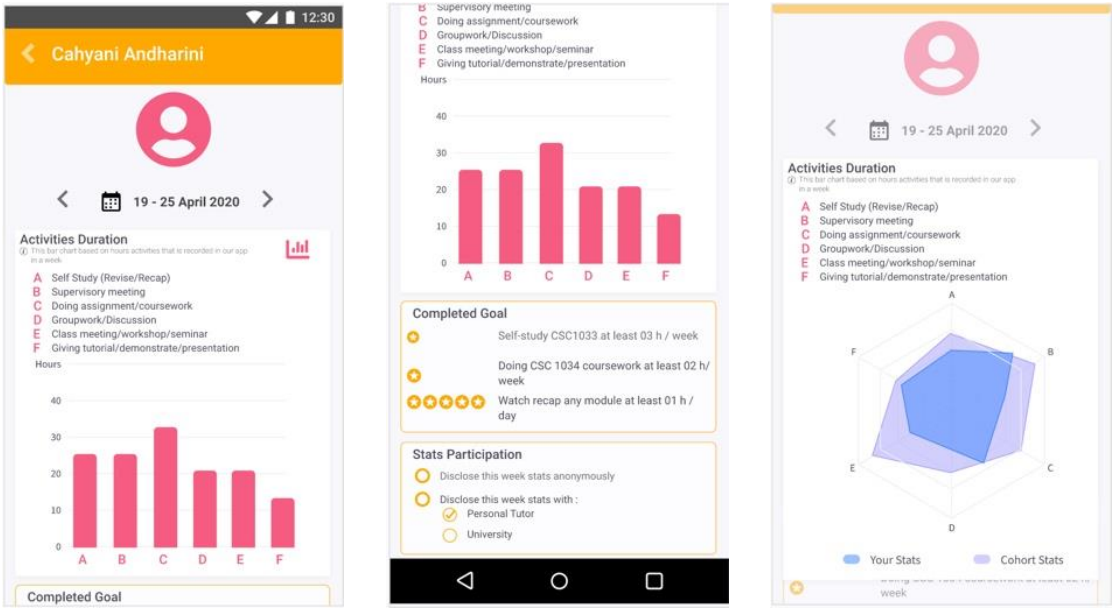
Daily timeline

Figure 6.7. Semi-automatic location tracking mode

All users ' visited places were recorded temporarily in semi-automatic location tracking mode (Figure 6.7). There were two buttons (and), so the users could select which visited locations they wanted to store permanently in their daily timeline. These options aimed to accommodate users' preferences for choosing whether to record or not record each place visited. After selecting which locations are to be recorded, a user may add activity details in the visited location record. The temporarily visited location record uses a grey typeface. After it changes to record permanently, the colour changes to black.

Task 8. View user and cohort weekly stats

The user's statistics can be accessed through "User Profile" in the Settings menu. On this page (Figure 6.8), users may see the report of their activities over a specific period. Users also may see their completed weekly/daily goals. Furthermore, users can compare their performance with their cohort.



Personal statistics *Personal statistics* *Comparison with cohort stats*

Figure 6.8. View user and cohort weekly stats

6.2. Findings

The usability issues for each task were:

Task 1. User Registration

Users find the design easy to understand. All participants were able to complete the task; both registering as a new user and logging in. So, there were no usability issues in the User Registration scenario.

Student02 *"I think it's very easy. It's a common way to do log-in in every app, so... it's very easy."*

However, there were some suggestions for the User Registration task. The first suggestion was related to the registration scenario: users prefer to see the app directly after registering an account so they do not need to log in again.

Student04 *"I think it's easy to register but I think after registering, it will be better to just go in the app and not having to login page again."*

Another suggestion was related to the design layout about the title location and background colour of the registration form.

Student06 *"Mm.. it is about the layout. Because I have a design background, so for me the title, the black font login, it is much better you to put it downs under the orange colour to make it's clearer, rather than overlay with the text and the colour in between."*

Task 2. Goal Management

The scenario to create a goal was easy for the participants. However, they reported that the bottom navigation design needs to be improved to make it clear and understandable, even by first-time users. Students feel they did not understand what each symbol meant. They were just using trial and error to find out which page each button lead to. Their suggestions were to use simple words for each sign and use a home sign that leads users to the home screen.

Student02 *"I think it's okay but I need time to choose which icon that present the weekly goal progression because I don't really understand what this sign mean."*

Student06 *"I can't find home button which lead us to every screen."*

Student04 *"Use simple word and icon to make it more nice and clear."*

Student05 *"It's really hard for me to find the goal tracking icon."*

The participants also mentioned that the information was too dense, so it needs more space to make it look clearer. Their suggestions were either using a box outline or different background colours for each goal to adjust the space within the Goal Management screen.

Student04 *"Maybe we can have each box for each task. Or maybe you can add make an option like different colours symbol for different task."*

Student 07 *".. in my opinion, you can just use different background colours, just to differentiate each record."*

Students who felt that the information was too dense also suggested displaying only weekly or monthly goals, not the daily goal. They preferred to show weekly or monthly goals because they felt it was more suitable for measuring or evaluating their goal progression.

Student03 *"It would be better if you choose one, either weekly or monthly… Because if you set daily then people feels like it's kind of hard to see the difference in day to day. I mean, people are more likely to see that improvement in weekly or monthly. Just pick one of the options."*
Student07 *"I think if people if people want to see this kind of page, they don't want to see the detail. But I think they want to see the general picture. So you don't have to like put detailed information on this interface, like the daily goal."*

There was also a suggestion to improve the filled bar chart of goal progression by adding the number or percentage to make interpretation easier.
Student05 *" …It is maybe for the percentage to know the progress to help that we already done at all or not at all. Also it's better for you to put number at the presentation of the progress."*

Task 3. Schedule Management

From the interviews, all students reported that the design of the Schedule Management scenario was straightforward and understandable. Most students managed this task intuitively. However, their main concern was the three icons in the bottom navigation confusing them. They kept trying and guessing which page was opened using the buttons in the bottom menu during the experiment.
Student05 *"Yeah, it's pretty understandable. We can see the location, and the description perfectly."*
Student02 *"For this part, I think it's already, it's Okay. It's understandable. My main difficulty is the three icons here because I don't understand it."*

Some participants felt that the scenario was almost similar to the design to set a schedule in either Google Calendar or Office 365 calendar, a familiar tool for the users. Therefore, they expected that the schedule management had at least some similar features to the commercial ones.
Student06 *"This is the same thing with office 365 calendars. That they have choice for one day or two days before, I'm not really sure. But usually, I set up all my meetings a day before."*
Student07 *"Yeah, I think it's fine, but I'm not sure as we use this email from outlook. I think it almost the same when we have an event or an agenda or appointment or anything*."

Task 4. Settings menu

There were some suggestions from the participants for this task. Almost all participants had difficulty finding the icon to direct them to the Settings page. Some students pointed out that the button's colour blended with the map's background colour, so the button was not clearly visible.

Student01 *"Because I couldn't find this icon here, I can't really see it. I thought that it just the map."*

Student02 *"the colour (pointing at the Settings button) is grey, and it's not very visible because of the background is a map."*

Student03 *"I think the colour of the settings button is not really clear. So it is blended with the background."*

Some students had difficulty locating the button since it was at the top, unlike other control buttons which were located at the bottom.

Student06 *"it's better to put this menu icon in the bottom as well rather than putting it on the top because previously all the control are here... So we just need to go to one area that we need the setting to go through."*

Student04 *"maybe you can put it in the bottom menu and put the name of the picture (symbol button)."*

Student07 *"... actually you can make this menu about tracking to be more obvious on the bottom menu."*

There was also a suggestion to make users more aware of what they had done by changing the settings mode.

Student01 *"I mean it will give more information to the user that you can choose between the options. It's like to have a pop-up screen at the first time you use it (to make the user more aware of the available option)*."

Task 5. Automatic location tracking mode

In this task, most users found that the scenario was understandable. However, some students suggested putting short texts to indicate what the symbols meant, or to let them choose their own symbols.

Student02 *"Maybe, below these icons, you can like put just a short text to indicate what are the functions of the icon."*

Student03 *"Yes, maybe it could be better if it is like a text than the symbol, the icon (pointed at* activities *type icon)."*

Student07 *"…to just avoid misleading of the meaning of this symbol so that you can add short text here (near the symbol)."*

Students repeated their opinion regarding the bottom menu since they still had to guess what the symbols meant. Therefore, students had difficulty since they needed to click on the symbols one by one to know their meaning when completing this task.

Student02 *"Maybe I just do not understand the three icons here (bottom menu) because I don't use this kind of app, So, it's very new for me."*

Task 6. No location tracking mode

In this task, most students also felt familiar since the scenario was similar to the previous task, so there was no suggestion for this scenario.

Student03 *"It's understandable, it's not confusing."*

Student05 *"well, I think it's pretty easy to use."*

Student06 *"yeah, it's easy."*

Task 7. Semi-automatic location tracking mode

Most students did not have difficulty with this task since the scenario was similar to the previous one. However, there was a suggestion about ordering the recorded location to put the first visited location at the top.

Student02 *"I think the order of the location, I'm not really sure like which start first, And I think, maybe for me it would be more make sense if the first order will be put in the first box."*

Task 8. View user and cohort weekly stats

Most students feel that this task scenario was a bit complex and challenging. Some suggestions were about the layout and components used to view the user statistics. Considering the menu name, students felt that "Statistics" was a more suitable name to represent the page for viewing user statistics.

Student04 *"yeah, and about the tab name to go to this page, instead of putting it under "User Profile", I prefer to use "Statistics"."*

Student07 *"I'm sorry, in user profile you can show about the name of the user, which I think that is related to the individuals information."*

There were also stars based on their progression goal on this statistics page. The aim of this star was as a reward for students that completed their goal. One star was given for one completed goal. However, students mentioned that they preferred to see the goal progression in a bar chart rather than visualised with stars. The students also recommended that the goal completion information be displayed on different screens, not the "Statistics" screen. Therefore, the bar chart in Task 2. Goal Management is already fulfilling their required information regarding goal progression.

Student03 *'Because I think if people if people want to see this kind of page, they don't want to see the detail. But I think they want to see the general picture. Because too much information still does not guarantee that people will understand what they have been going."*

Student04 *"maybe you can have a simplified version on here, and put a button that will access to the completed goal progress page."*

Student05 *"My recommendation is. I think it can be separated. This one is on one page, and the completed goal with the participant can be on the other page."*

Student07 *"We shouldn't set too much information about one star two stars as the apps can calculate automatically based on the .. (goal progression) yeah."*

Students also pointed out that they prefer using a bar chart rather than a spider chart to compare their achievement to their peers. They felt that reading and interpreting a spider chart was not easy. Therefore, they suggested using a simple bar chart.

Student02 *"I think it's confusing to see the graph like this. Maybe I would understand better if the graph is just like simple like a bar chart."*

Student03 *"I think radar chart is not really common for the users, so it's kind of hard to interpret which area that I am best at."*

Student04 *"I think bar chart is easier because we use to use it more often than the spider chart."*

Student05 *" I don't really understand to read the spider chart."*

6.3. Design Refinements

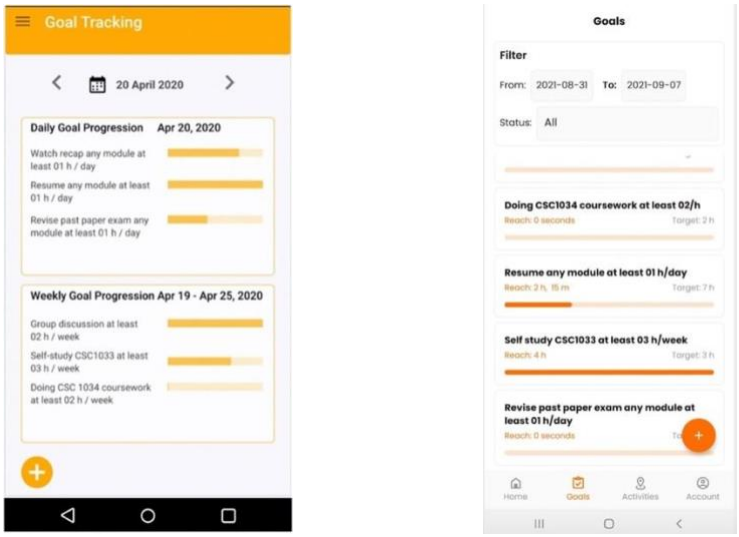
The participants highlighted common usability issues, mainly UI design issues, including layout/readability and navigation/paging issues. Based on the observed results and feedback from the participants, we proposed design refinements to develop a personalised mobile app for students to manage their time. The design refinements were:

1. Layout/readability

   This category deals with issues relating to the app'sgeneral layout and readability. Most users' feedback was about the interface presenting too much content, text, and questions, which could overwhelm users. For example:

   a. Some participants said that the text in the Goal Management page was too dense and wanted to have more detail of the progression bar, such as the hours achieved and target hours. Users also felt that too much information came by providing daily and weekly goals. The use of weekly goals itself was enough to help them record their goals.

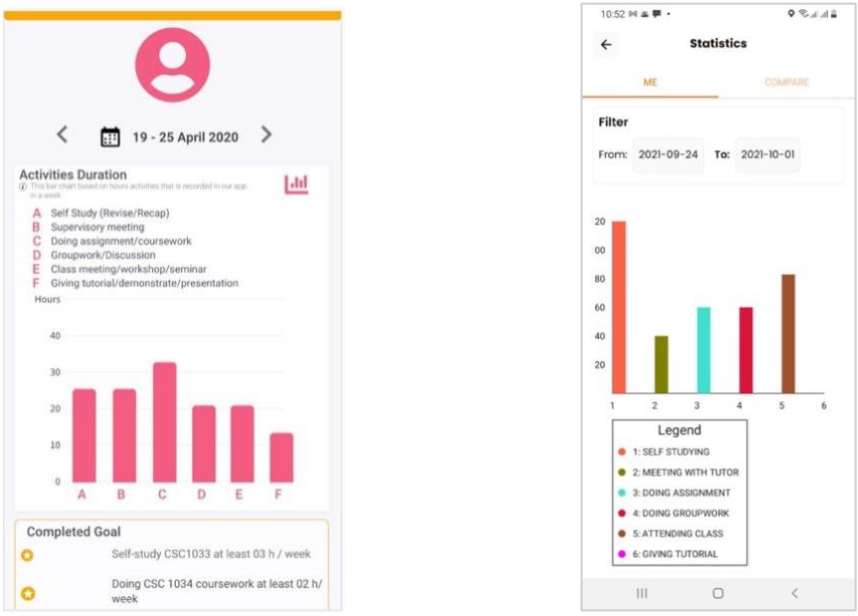
      Figure 6.9 shows the design refinement for the Goal Management page. Before the improvement changes, daily and weekly goals were arranged in different boxes. The progression bar is the only bar that shows the hours target and is filled with reached hours. After the improvement changes, there are only weekly goals and no daily goals. The achieved and target hours are provided near the progression bar.



Before refinement *After refinement*

Figure 6.9. Design refinement for Goal Management page

b. The students felt that there was too much information on the Statistics page. They prefer to see the completed goal in a bar chart rather than a badge. Figure 6.10 shows the design refinement for the Statistics page. There were badges (stars) showing the completed goal before the improvement changes. After the changes, the badge information was omitted from the Statistics page.

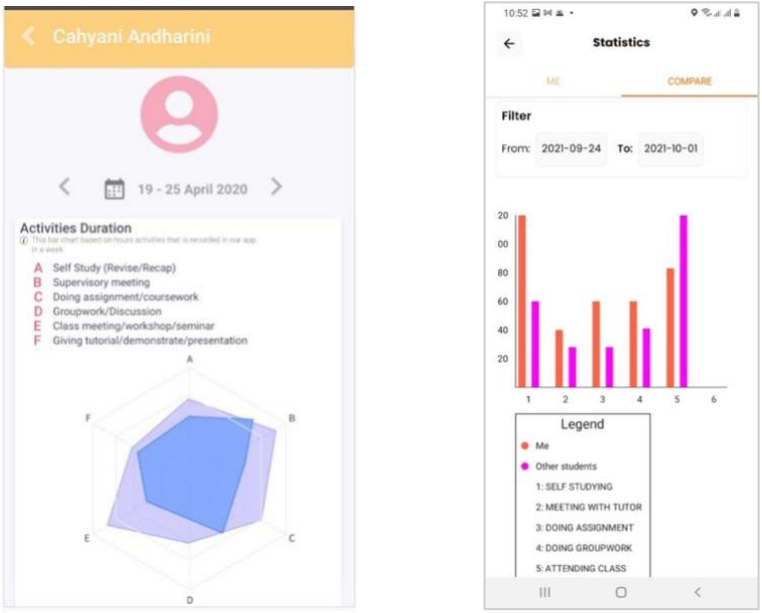


Before refinement *After refinement*

Figure 6.10. Design refinement for the Statistics page

c. The participants reported that the spider chart was unfamiliar to them and preferred the bar chart instead for statistics comparison with their peers. Figure 6.11 shows

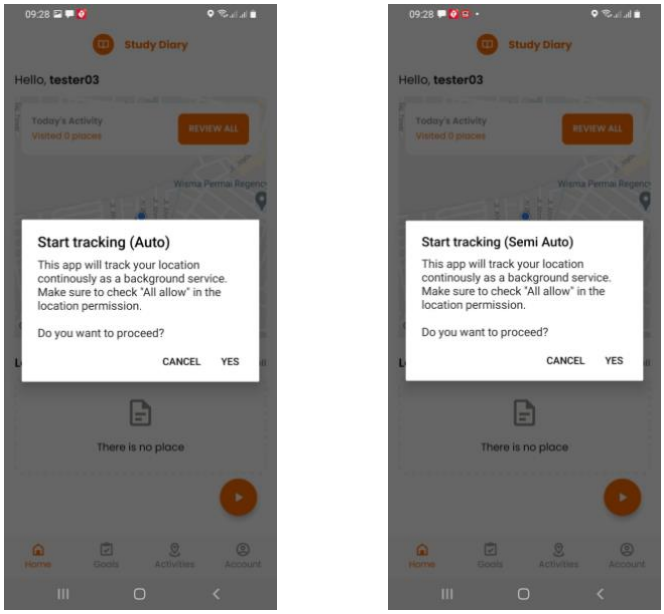
the design refinement for comparing with peers on the Statistics page. Before the improvement changes, there was a spider chart to compare personal and peers stats. After the improvement changes, the comparison was shown in a bar chart.



Before refinement *After refinement*

Figure 6.11. Design refinement for the Statistics page

d. There was also a suggestion to make users more aware of what they had done by changing the settings mode. Figure 6.12 shows the alert when users change the location tracking setting mode.



Auto tracking alert *Semi-Auto tracking alert*

Figure 6.12. Design refinement for alert of changing location tracking mode

2. Navigation/paging issues

   Some users' feedback was that they suffered from poor navigation and found it difficult to return to a previous page or the home button. The navigation refinements that were made are explained below.

   a. Users have difficulties using the navigation since they were confused about the meaning of the symbol buttons. They also suggested putting all the control buttons together in the bottom navigation to make it easier to use the app. Users also recommended using short texts indicating the icon function. Figure 6.13 shows the design refinement for bottom navigation before and after the improvement changes, with short text near the symbol at the refined bottom navigation to indicate its meaning. Furthermore, the 'Account' button is also placed in the bottom navigation to help users navigate the application more easily.

Before refinement *After refinement*

Figure 6.13. Design refinement for the bottom navigation

   b. As the main feature of the app, changing location tracking settings was supposed to be evident to students. However, students find changing the location tracking mode a bit complicated. Figure 6.14 shows the steps for users to change the location tracking mode in the old design. Firstly, users need to click on the Account menu on the left top and select Settings. Users then may change the location tracking mode in the Settings form. Some students mentioned that these steps are too long and want to be more straightforward. They suggested that changing location tracking mode should be done on the main screen to make it evident to users because it is the app's main feature.

   Students also complained about the grey colour of the Setting button, which blends with the background. This situation made students feel challenged to find the button. Therefore students suggested using bright colours to differentiate from the background colour. Using an eye-catching colour for button design is supposed to help users be more aware of the button position on a screen.

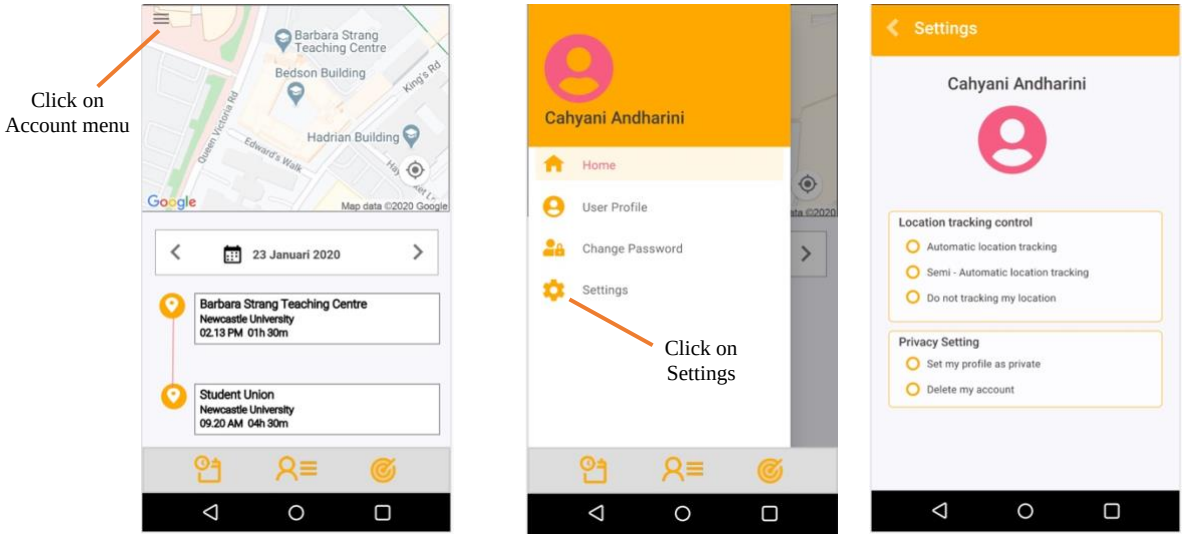


Figure 6.14. The changes of the location tracking mode scenario (before refinement)

Figure 6.15 shows the steps to change the location tracking mode after improvement. Users only need to click the Play button (toggle button) on the Home screen and select the location tracking mode from the floating menu. This improvement reduces the steps to change the location tracking mode and makes the menu evident on the Home screen.

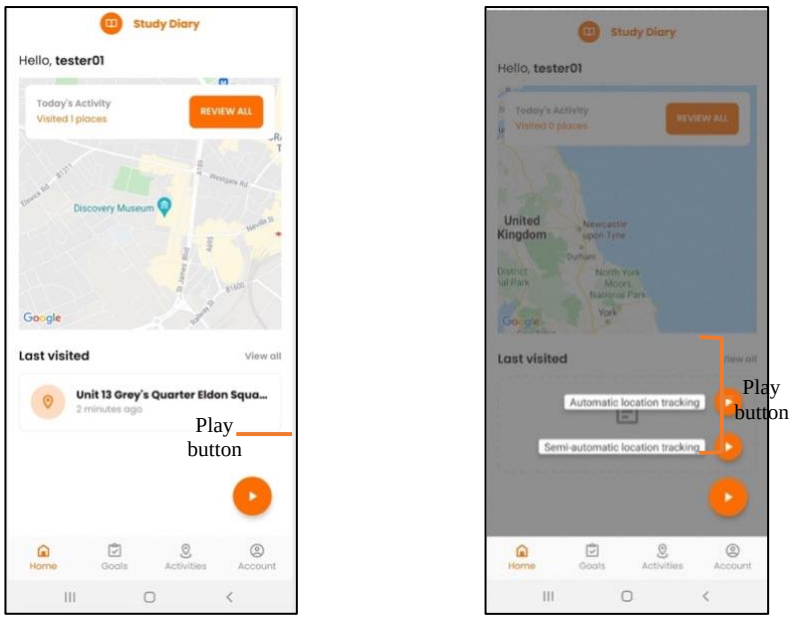
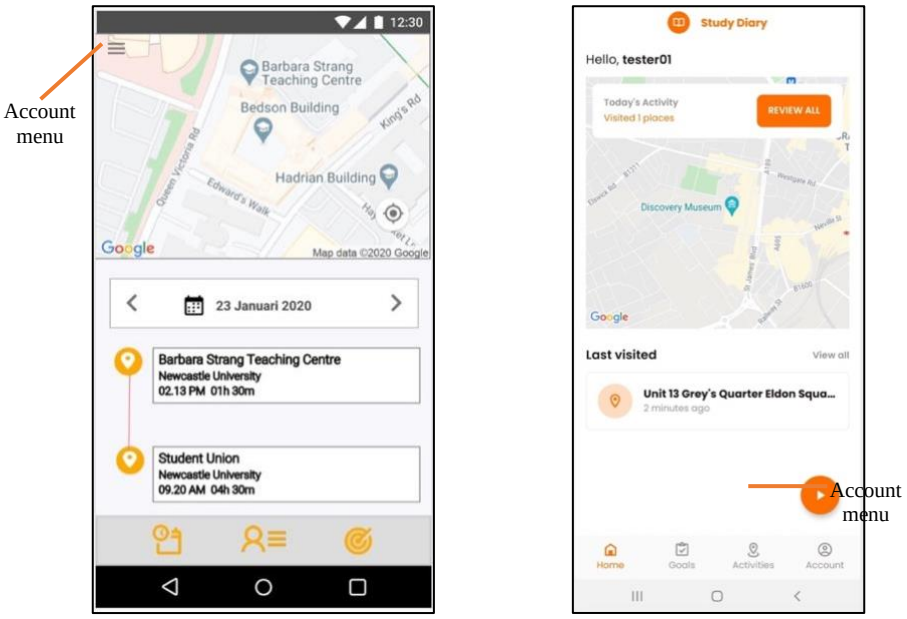


Figure 6.15. The changes in the location tracking mode scenario (after refinement)

c. Users faced difficulties with the menu button position, which was blended with the background. Figure 6.16 shows the design refinement for the location of the

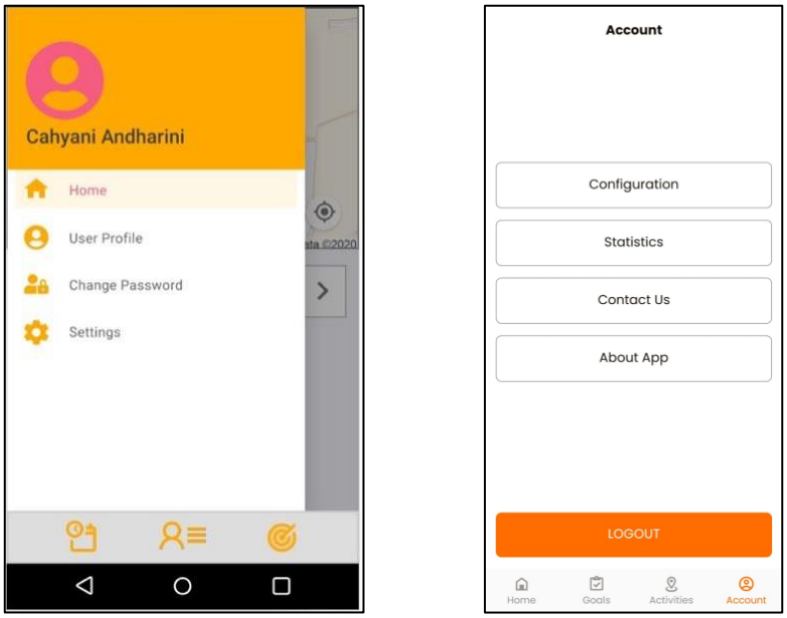
Account menu. The menu before the improvement changes is on the left top and overlaid with the map. After the improvement changes, the menu is located at the bottom to help users to focus the navigation only on the bottom menu. This menu movement is based on the participants' recommendations. While doing the task in usability testing, we also found that respondents needed extra time to find the Account menu.



Before refinement *After refinement*

Figure 6.16. Design refinement for Account menu location

d. Users also recommended putting the personal and peer statistics under the "Statistics" menu rather than the "User Profile" menu (see Figure 6.17). They felt that the name of the "Statistics" menu is more representative of showing the user statistics. The menu before the improvement changes is located on the left top under the "User Profile" menu. We improve the design by putting the menu at the bottom navigation under the Account menu. Placing the menu in the main navigation of a screen may help users locate it.



Before refinement *After refinement*

Figure 6.17. Design refinement for the “Statistics” menu

6.4. Discussions

Usability evaluations are essential to improve not only the interface design of the mobile application but also the interactions between devices and users. The assessment can be done remotely, where the participants used the mobile application in their own environment to capture users' actual behaviour. The moderator's presence may cause biased results because it creates a dimension of artificiality that may hinder the research goals. However, the moderator's attendance with low involvement helps the participant stay within the study’s scope while allowing them to be in the driver's seat to make the evaluation as realistic as possible.

Below are several guidelines for a mobile design application to help students’ time management skills obtained from this research stage.

1. The progress bar chart should be equipped with numbers to make users see their goal achievements clearly.

   A progress bar chart with a filled and empty box is good for showing users their achievement of the goal (Kang et al., 2023). In our design refinement, we add information about the number of achieved and goal-target hours. This refinement is similar to Babich's (2018) suggestion to not just rely on colour to convey information. He advised using other visual signifiers to ensure that users can interact with an

interface. Here in our refinement design, we add the number of hours to the progression bar, representing the achieved and target hours.

2. Keep the amount of information in one screen design at a minimum and simple.
   On the Statistics page, we minimize the content and the interface as suggested by the users. We removed the badges section, which shows the completed goal achieved by the users for a certain period. The Statistics page focused on providing information about the duration of each activity for some specific period. This design refinement supports Babich's (2018) suggestions to keep the content and interface elements to a minimum. In our refinement design, we use a simpler design to keep the users at ease using the product. Maintaining the simplicity of apps' design is essential, as Alsswey and Alsamarraie (2020) suggested simplicity positively correlates with the user's intention to use the apps. Additionally, Mohanty et al. (2021) noted that the cognitive load may be decreased by the user interface's simplicity and the limited amount of information on a single screen.

3. Use the typical type of chart that users are familiar with.
   The Spider chart, also called a radar chart, is often used to show comparisons in several dimensions. Radar charts are two-dimensional graphics used to plot three or more series of data on several quantitative variables (Chalal et al., 2022). Consequently, this visualisation technique is excellent for comparing features across numerous categories or groups (Ahmed et al., 2022). Radar charts' versatility in depicting temporal shifts across various dimensions is yet another benefit.

   However, the users in this study felt unfamiliar with the spider diagram and preferred to see a bar chart. Goldberg and Heffman (2011) also suggested that a spider chart may effectively assess the symmetry of values and has been used in the business domain. Similarly, Cisneros (2021) reported that spider charts could be visually appealing and encode a lot of information in a relatively small area. However, an unfamiliar audience may need more effort to understand the chart. Therefore, he suggested using a more commonly-used chart to help the audience. In our study, we changed the spider chart into a bar chart to visualise the comparison of students' behaviour and their peers.

4. Provide relevant feedback on users' actions.

   Lupanda and Rensburg (2021) mentioned that we need to acknowledge that users' actions have been received by providing them feedback after interacting with the app. The communication medium may be modal alerts, confirmations, or push notifications. Since the location tracking mode is essential for users' privacy, in our refinement design, a modal alert appears each time users change the mode.

   Soni et al. (2019) recommended to give immediate feedback from users' action. In their application, they provide on-touch event which provide feedback and confirmation of accepted touch input using animation or sound. Moreover, Babich (2018) suggested that the delivered information should be valuable, cover what users need and be well-timed. Too many alerts or push notifications often appearing in the application could annoy the users. Therefore, in this study we only use alerts or confirmations for the essential features.

5. The combination of the symbol button and short labels help users predict what happens after clicking the button.

   Regarding the refinement of app navigation, we added a label near each symbol button. The participants in this study indicated that they needed help to find the appropriate button to complete the given tasks. Babich (2018) suggested putting a button's label that describes its action to help users understand what happens after clicking it. The presence of clear labels minimizes the users' frustration with their first-time experience when interacting with the apps.

   According to Soni et al. (2019), textual or audible labels are required for clickable icons. Due of their cognitive ability, the audible label is appropriate for children aged 2 to 7 years. In addition, Soni et al. (2019) recommend a minimum font size of 14-point text for the label (0.5cm). Combining a symbol button with an appropriate label aids users in anticipating the function of the button. According to Ejaz et al. (2019), the predictability of the UI interface is essential for users to comprehend and feel confident when they click the button.

6. Use contrast colour and flat hierarchy to make the navigation evident to the users.

In our study, the participants indicated that they had difficulty finding the burger button at the top-left of the screen due to its colour blending with the background. The participants suggested using more eye-catching colours for buttons to make them clearly visible and self-evident. In our refinement design, this burger button that contains the top-drawer menu is removed and merged into the bottom menu so the users can find the menu easily. This refinement is opposed to Lupanda and Rensburg's (2021) recommendation on placing top-level menus in mobile apps. They suggested using a top-level menu in mobile apps since it may help users to find it easier to interact with the top-level menu using one thumb.

However, Ahmad and Ibrahim (2017) suggested that using a flat hierarchy on smartphones is preferable since it requires fewer steps. They recommended using a shallow structured menu rather than a deep hierarchy, like a drawer menu at the top level of the screen. Similarly, users in our study suggested putting all the menus in the bottom area so they could quickly notice them without searching the menu on the whole screen. The bottom menu is also preferable since the menu architecture is horizontal, so more menu is visible to users without users clicking on them. Babich (2016) also suggested making the navigation feel like an invisible hand that guides the users to click on the menu. Therefore, the refinement navigation in this study uses the bottom menu to make the navigation visible and self-evident for users.

7. Simplify the steps needed to complete the tasks.
   The steps to complete such task in a mobile application should be clear and concise (Sushra et al., 2022). The user experience is enhanced with a pleasant user interface that prioritizes robust interfaces while retaining a minimalist design (Sushra et al., 2022). Minimalism ensures a smooth and mind-easing user experience, simplifying things and staying focused on the necessary information. According to Sandesara et al. (2022), minimalism must be adhered to while building a simple and effective mobile user interface.

   In our refinement design, we simplify the steps required to change the location tracking mode by using a floating button in home screen. Since the location tracking mode is the main feature of this app, using a clear floating button helps users to find it easily and reduces the steps required to change the location tracking mode. Most participants

in this study indicated needing help changing location tracking mode. Therefore, placing the button to change the location mode on the main screen helps the participants to find the button easily since the floating button was designed to stand out (Babich, 2017). The floating button performs frequently clicked buttons or the most relevant actions of the main apps' feature. As suggested by Ferreira et al. (2020), the floating button was placed at the lower right corner of the app's screen as it is a thumb zone area.

8. Use the appropriate label that is compatible with users' expectations.
   The participants suggested that the User Profile menu doesn't contain information such as the statistics of a user's activities duration that the app records. In this study, the participants suggested using the term "Statistics" to display their weekly data instead of the word "User Profile". Almao et al. (2019) suggested using simple, self-explanatory and non-ambiguous functional labels a fundamental role in UI design. Therefore, in our refinement design, we use the term "Statistics" as it is the one that is acceptable from the users' point of view. Furthermore, O'Hara and Fleger (2020) reported that the design result should be compatible with users' expectations. Therefore, changing the label name is a natural way to respond to users' feedback.

The gamification scenario that some students in our previous study wanted needs to be explored further. In our design, we used badges as stars as rewards when students accomplish their goals. However, students found this gamification less enjoyable at this stage and preferred the goal progression bar chart rather than badges.

Since enjoyment triggers the production of the neurotransmitter dopamine in the brain, which improves motivation, attention, and consequently learning capacity, enjoyment is crucial for gamification (Acosta-Medina et al., 2020). The fundamental source of value for gamers is that use preference is prioritized over functionality (Acosta-Medina et al., 2021). The gamified system was designed so that people could enjoy using it without considering how it would affect performance. However, if the instrument is useful but unenjoyable, the preference for utilizing it is likely to be diminished (Yang et al., 2017). Taşyürek (2021) explained that we can rely on our creativity to provide countless gamification scenario ideas to boost user engagement to our app.

Gamification is integrating game mechanics into an app's user interface without disrupting its flow. Neupane et al. (2020) reported that several game elements could enrich a gamification scenario, including social influences, real-life incentives, collaborations, competitions, points, challenges, badges, goals, unlockable content, levels, high scores, narratives, and plots. Creating compelling gamification scenarios may increase users' motivation and enjoyment to use such an app. While gamification is popular nowadays, the research about it is still mixed because the mechanism is relatively complex. How different game elements can meet user needs for self-reflection is an essential consideration for activity-tracking applications. Below are example of mobile applications that successfuly incorporate gamification.

Duolingo [20] is gamified language learning that is popular worldwide and has been downloaded over 100M. Duolingo uses gamification at every stage and in every lesson, incorporating a variety of gamification components, such as points, hearts, and streak counts. Duolingo employs performance charts to motivate users by displaying streaks and daily goals. Way to earn in-app currency known as lingots by completing activities. Users can use these lingots to purchase additional amenities such as Power-Ups. Users of Duolingo require lives to pass tests, and when they miss, they lose lives. They must recover their lives in order to continue. Duolingo is an example of a successful app that has implemented active gamification over points, badges, and leaderboards. Furthermore, Duolingo allows users to communicate socially via Facebook integration and to build language clubs within the program.

Forest[21] is a productivity software that has been downloaded over 10 million times and is a Google Playstore Editor's Choice. With the Pomodoro timer, this software helps its users stay focused by requiring them to put down their mobile phones in order to enhance productivity and get motivated. When users need to concentrate, they can set a timer, put down their phone, and begin growing a tree. The sapling will grow progressively over time. The users' tree will perish if they use their mobile phone while they are prohibited from doing so. If the users have been attentive, the sapling will develop into a large tree. With each successful planting session, users get coins. Coins can be used to unlock unique tree

[20] https://www.duolingo.com/
[21] https://www.forestapp.cc/

species and plant actual trees on the planet. Forest app is an example of a novel concept for a mobile application that increases productivity via the use of a fun gamification scenario involving the planting of both virtual and real trees.

In our study, participants in our group discussions have opposed the use of leaderboards. Due to the app's purpose of aiding students' self-reflection in time management, a comparison with other users would bias the app's purpose. This situation is similar to Duolingo and Forest app which also do not have leaderboards element. According to Raftopoulous (2020), users become more sensitive and reject leaderboards nowadays. Participants in their study, which global organizations that has been used gamification for at least four years experience reported that to make the gamification attractive, they supposed to do experimentation with the different game mechanics.

The user storyline of our application is perhaps less entertaining than those of best-practice gamified mobile apps like Duolingo and Forest, which is presumably why students aren't interested in our gamification scenario. These programs, Duolingo and Forest, have fascinating narratives that make users unconscious that they are completing their goals while enjoying a gamification setting. Prakasa and Emanuel (2019) suggest that while orienting users to the activities they must do as part of the gamification scenario, we may make the experience more engaging by include a tale. Afterward, instead of simply writing the situation, let the characters in the software to tell the tale via conversation in the speech bubbles. Adding a difficulty level or a role that users can choose is another way to make the storyline more creative and fun. Further research might be conducted to enhance the story and gamification environment.

To sum up, a usability test conducted to explore users’ experiences have identified design issues that will provide direction in the next stage of product development. The recommendations arising from this study will be implemented in the final version of the mobile app, and a further user experience evaluation is planned.

Chapter 7. User-Experience Evaluation on Mobile App

This chapter's objective is to get user-experience (UX) feedback from users in their natural surroundings. The benefit of this technique is that UX tests in users' natural environments may demonstrate how users really engage with the app (Kjeldskov and Skov, 2014). According to Vermereen et al. (2010), evaluating a product in the real-environment gives a more realistic situation in which to collect more reliable user experience data. The perceived value and happiness of users are crucial components for acceptance and app engagement (Kim et al., 2013). These also contribute to the long-term usefulness of the app, since the app may be tested with end users in natural settings.

Using design refinements from the previous chapter, the application was developed into a mobile app. The participants were then instructed to install the app on their smartphones in order to interact directly with the program and assess how it would support self-reflection in time management. Students responses then were utilized to verify the whole process of the study.

7.1 User Experience

In the last several years, there has been a definite trend toward extending the usability idea to a more comprehensive perspective on how people interact with systems—often referred to as user experience (Shin et al., 2020). User Experience (UX) is essential to either success or failure delivered product to user (Hinderks et al., 2022). UX designers are not just concerned with developing usable goods. Usability, which to some part refers to how simple a product is to use, is sometimes mistaken with user experience (UX), while it is true that UX as a discipline originated with usability. They focus on other elements of the user experience, such as enjoyment, efficiency, and entertainment. UX has expanded to include far beyond usability (Konstantakis et al., 2020), and it is crucial to give focus on all aspects of the user experience in order to get successful products to users.

According to the ISO (ISO, 2009), UX is often defined as "a person's perceptions and reactions that come from the usage or expected use of a product, system, or service". This brief yet insightful explanation explains that UX primarily focuses on the subjective aspects of user perception, thinking, and emotion in human-computer interaction. Moreover, the

temporal component is crucial since UX is a dynamic phenomena that evolves over time. Therefore, there is no singular description of a satisfying user experience. Instead, a strong user experience fits the demands of a single user in the context in which they use the product.

A user experience is characterized as a collection of unique quality standards including goal driven or pragmatic quality, such as efficiency and controllability, and non-goal driven or hedonic quality, such as stimulant, fun-to-use, innovation, feelings, and aesthetics (Hassenzahl, 2007). It combines traditional usability requirements such as efficiency, effectiveness, and simplicity with extra factors such as enjoyment, aesthetics, and attractiveness. The benefit of breaking down the broad concept of user experience into a number of straightforward quality criteria is that they describe several, reasonably well-defined, and different components of user experience that can be independently assessed (Mkpojiogu et al., 2022). The questionnaire for end-users may assess user experience fast and easily, ideally including a thorough picture of the UX of the product.

7.2 User Experience Questionnaire

Standardized questionnaires for UX evaluation consist of a series of questions that are always presented in the same sequence. The majority of user experience surveys use Likert scales or semantic differentials to capture user feedback on the pragmatic or hedonistic qualities of the product. As pragmatic traits, we interpret certain qualities as if a product is predictable, perplexing, straightforward, or complex, etc. On the other side, hedonistic features are those that appeal to sensations, such as whether a product is dull, intriguing, unique, or disappointing. These characteristics are related to stimulation traits as well as those associated to identification and evocation traits, such as the capability of a product to connect with others rather than isolate.

Standardized questionnaires are affordable and simple to use because they are self-administered by the user based on their perceived experience after utilizing a product or service. Moreover, they are deemed dependable and valid for measuring the user experience. AttrakDiff, proposed by Hassenzahl et al. (2003), is a standardized surveys which consists of 28 items, each of which is composed of a 7-point semantic differential. Later, Minge and Riedel (2013) developed the meCUE questionnaire, which was

comprised of 33 questions with 7-point Likert scales. In addition, Schrepp et al. (2015) introduced the "User Experience Questionnaire" (UEQ), which is comprised of 26 items constructed using 7-point semantic differentials.

Compared to other user experience survey, UEQ offers a more thorough study of the user experience (Julian et al., 2021). It helps users to express their feelings, opinions, and attitudes towards the evaluated product in a concise and efficient. UEQ also offers a free analysis tool for accurately analyzing the results. Our research used the User Experience Questionnaire (Schrepp, 2015) to assess the UX of application. This UEQ has a seven-point Likert scale scoring from -3 to 3. This questionnaire's clarity and precision are enhanced by the inclusion of six scales that represent the questionnaire's essential features. The UEQ relies on the notion that the user experience may be calculated by analyzing the usability and user experience goals. This questionnaire is designed to do a rapid evaluation of a product's user experience.

Six scales form the UEQ:

- Attractiveness (6 items)

  This scale measures the overall impression consumers have of a product in order to determine whether they like or hate it.
- Perspicuity (4 items)

  This scale evaluates the product's usability. This category's items seek to determine if the product is familiar to the user.
- Efficiency (4 items)

  This scale evaluates the interaction between users and products in order to determine whether or not users are able to complete activities effectively.
- Dependability (4 items)

  When interacting with the product, the user's feelings are in charge. This scale seeks to determine if system behavior is predictable so that users feel in control of the application.
- Stimulation (4 items)

  The purpose of this scale is to evaluate the joy and motivation derived from using the product.
- Novelty (4 items)

This scale seeks to determine if a product's presentation is unique, imaginative, and creative enough to attract users' attention.

The attribute of each scale is shown in Figure 7.1. Furthermore, UEQ has three principal characteristics: attractiveness, hedonic, and pragmatic quality, as displayed in Figure 7.1.

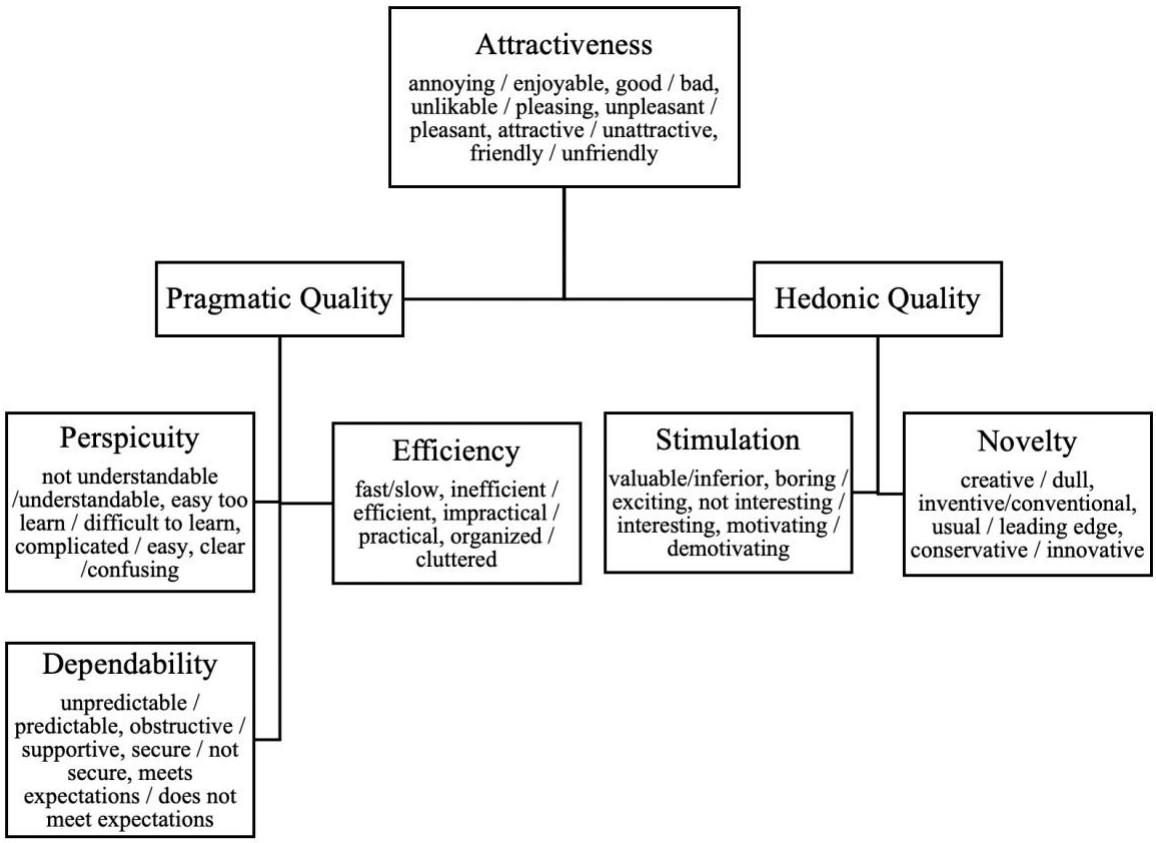


Figure 7.1. UEQ Design (Schrepp et al., 2015)

Scales are not assumed to be independent. The Attractiveness scale captures a user's general impression, which should be influenced by the values on the other five scales (see Figure 7.1). Efficiency, Perspicuity, and Dependability are task-related UX aspects (goal-directed), and Stimulation and Novelty are non-task-related UX aspects (non-goal-directed) (Laugwitz et al., 2008).

Attractiveness is a pure valence dimension, and it is assumed that the rating concerning this aspect is influenced by task-related and non-task-related factors (Schrepp et al., 2014). The questionnaire and some information concerning its application and an Excel-Tool for data analysis are available free of charge at www.ueq-online.org.

The UEQ responses from the participants are scaled from -3 to +3. For example, when a participant selects number 1 on the Likert scale of a question in the UEQ, the said question was scored -3. On the other hand, if they answer 7, the said question was scored 3. The total score of a question was used to calculate the mean score of one question. The mean of the scores was used to calculate the attribute score by calculating the average of the score means. The most negative answer is -3, 0 neutral, and +3 is the most positive value. Scale values above 0 indicate a users' positive impression, values below 0 indicate a negative image. Due to well-known answer effects, like avoiding extremes, observed scales are generally in the neutral range, between -2 to +2. Higher values are rarely observed, so a value near +2 represents a very positive near-optimal impression of participants (Rauschenberger et al., 2006).

The UEQ scales' consistency and their validity were investigated in an online survey with 722 participants and 11 usability tests with 144 participants in total (Laugwitz et al., 2008). These studies showed a sufficiently high scale Cronbach's Alpha which measured the internal consistency. In addition, several studies showed a good construct validity of the scales. There is a general question of whether the product's UX is sufficient to fulfil the overall expectations of users when a new product is launched. Therefore, this question can be answered by comparing the results for the product with the results of a large sample of other products, i.e. a benchmark data set. For the UEQ, such a benchmark was developed in the last couple of years (Schrepp et al., 2017). This benchmark helps interpret measurement results. And especially helpful in situations where a product is measured with the UEQ for the first time, i.e. without previous evaluation. A considerable number of contributors shared the results of their UEQ evaluation studies to create the UEQ benchmark. Some data come from scientific studies using the UEQ, but most data come from industrial projects. The benchmark currently contains data from 21175 persons from 468 studies concerning different products (business software, web pages, webshops, social networks)[22].

[22] https://www.ueq-online.org/

7.3 Data Collection

7.3.1 Materials and Procedure

The students use the apps to record their activities for two weeks to get an interactive experience with the mobile app. The students may start to use the mobile application at their own availability time. During the testing, the students make notes regarding their experiences and problems. This note will help them to support the retrospective questionnaire. The taking notes method gives better results than just retrospection because the action allows the participants to remember thoughts, not reconstruct otherwise (Van Someren et al., 1994).

During the user-trial phase, students were further required to complete a number of prescribed tasks. Students were asked to rate the app on a Likert scale from 1 to 7 using the UEQ questionnaire list (Schrepp et al., 2014). Additionally, students were asked to answer open-ended questions to assess how satisfied they were with the mobile app under test. The questions ask students about their experience while performing the tasks and the improvements they would recommend for the feature being evaluated. After they had used the app for a predetermined amount of time, we gave the respondents a Google Form questionnaire to complete.

7.3.2 Participants

This UX evaluation aims to discover design problems and insights from users' views. Following the UEQ handbook, there should be at least 20-30 respondents to get reliable results (Schrepp et al., 2014). Participants in this study were selected from the previous research stage and then extended using snowball sampling. We obtained 26 responses from students of various programmes at Newcastle University. Data collection was carried out from 25 January 2021 to 31 March 2021.

Degree Level	Gender	Age Range	Frequency
Undergraduate students	Female	18-23	4
	Male	18-23	5
Master students	Female	18-23	1
		24-29	5

	Male	18-23	1
		24-29	2
PhD students	Female	>30	4
	Male	>30	4

Table 7.1. Participants' demographic information

7.4 Findings

Cronbach's alpha reliability coefficient typically ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of the items in the scale (Gliem and Gliem, 2003). George and Mallery (2003) provide the following rules of thumb (p. 231):

"_ > .9 – Excellent

_ > .8 – Good

_ > .7 – Acceptable

_ > .6 – Questionable

_ > .5 – Poor

_ < .5 – Unacceptable"

Cronbach's alpha was calculated for each of the UEQ factors. From table 7.2 we may conclude that each factor was internally consistent since the value is above 0.70.

Attractiveness	0.93
Perspicuity	0.71
Efficiency	0.72
Dependability	0.77
Stimulation	0.8
Novelty	0.82

Table 7.2. Cronbach's Alpha

The overall results of the UEQ scale in our study are depicted in Figure 7.2 and Figure 7.3. The value of each UEQ item can be seen in Figure 7.3, where the highest average is on the Perspicuity scale (1.894). In contrast, the lowest average UEQ is on the Novelty scale (0.875).

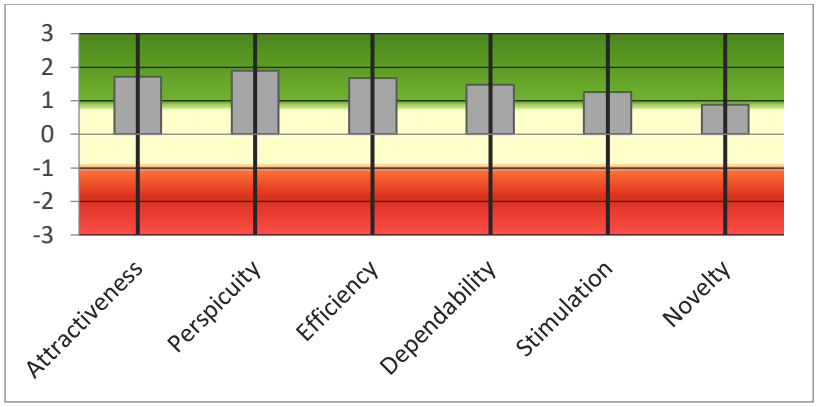


Figure 7.2 UEQ index scores on average for the application design

UEQ Scales (Mean and Variance)		
Attractiveness	1.718	1.19
Perspicuity	1.894	0.72
Efficiency	1.683	0.83
Dependability	1.481	1.05
Stimulation	1.250	0.87
Novelty	0.875	1.06

Figure 7.3. Mean and variance UEQ scale values (obtained from UEQ Data Analysis Tool)

Figure 7.3 shows the calculation of the means for every scale by revealing whether the findings are positive, negative, or average. According to the UEQ manual (Schrepp, 2015), a value is positive if it is greater than 0.8, neutral if it falls between -0.8 and 0.8, and negative if it falls below -0.8. In addition, Martono (2021) noted that the results are positive if the excel data analysis tool features rising arrows. Therefore, from Figure 7.3, we may conclude that the questionnaire results in our study are all positive user experiences.

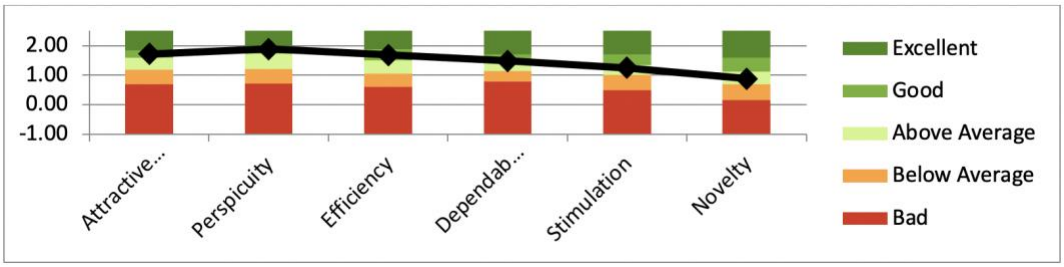


Figure 7.4 UEQ benchmark diagram of the mobile application

Scale	Mean	Comparison to benchmark	Interpretation
Attractiveness	1.72	Good	10% of results better, 75% of results worse
Perspicuity	1.89	Good	10% of results better, 75% of results worse
Efficiency	1.68	Good	10% of results better, 75% of results worse
Dependability	1.48	Good	10% of results better, 75% of results worse
Stimulation	1.25	Above Average	25% of results better, 50% of results worse
Novelty	0.88	Above Average	25% of results better, 50% of results worse

Table 7.3 UEQ benchmark comparison and its interpretation

In this study, we employed version 10 of the UEQ analytic tools, which includes a benchmark data set of 21175 people across 468 trials and a wide variety of items (social networks, business software, webshops, and web pages). We can determine the evaluated product's relative quality by comparing its UEQ score to the benchmark data.

Based on the UEQ benchmark results diagram in Figure 7.3 and Figure 7.4, the mobile application is included in the "above average" category for Stimulation and Novelty aspects. A value is considered in the "above average" category among the 25% best results from this benchmark data set. Thus, according to the UEQ, the overall quality of the mobile application is high. However, there is still room for improvement. Therefore, an additional questionnaire was carried out to determine the focus of revisions caused by these deficiencies.

We have some responses from the students from open questions, which are explained below.

1. Opinion or suggestion for improvement User Registration scenario

Generally, students do not have any problem with the User Registration scenario since the scenario is similar to registering a user for the first time in other apps.

Student 01 *"All good"*

Student05 *"If you can do it, you may give a reward for those users that just register. I think it would be like coins that the users may use to purchase some features later on."*

Student 17 *"I do not have any problem with user registration. However, more information sent in email or pop-up notification to let us know about the registration process and brief guidelines of how to use the apps will be better for us to understand the app."*

Student 25 *"This scenario is pretty much similar with user registration in other apps."*

2. Opinion or suggestion for improvement Goal Tracking scenario

Some students feel that completing the Goal Tracking scenario is easy, and there is no further suggestion for this scenario.

Students 06 *"Goal tracking is easy to complete."*

Students 14 *"Creating goal is easy to access by any level of user."*

Some students feel that inputting the time by clicking on the clock is a bit challenging. They prefer to type in the time since it is more straightforward.

Students *07* *"It's probably different for everyone, but I would prefer the "Type in time" options on the duration section as the default option to input time/duration rather than the physical clock. It's because the physical clock shows the current time rather than 00:00. It would be great if the physical clock is showing 00:00 duration during the start, but I would still prefer to type it as default since its more simple."*

Students 13 *"I think it would be better to type in the time instead of scrolling down to input the time."*

Students suggested adding features in goal tracking, such as a notification to make users aware of their goal progression. Regular notifications about goal progression may motivate users to achieve their goals. The students also mentioned the feature of prioritising a goal to help them to focus on more critical tasks/goals.

Students 17 *"Also, I think it would be good if there is a reminder. So the app may show notification on a specific period to remind users to complete their goal."*

Student 12 *"I hope that if you can do it, you can add feature to prioritize the goal. More difficult task is supposed to be get higher priority because we need more time to complete it."*

3. Opinion or suggestion for improvement Settings scenario

Overall, students found that the Settings and configuration of the mobile apps are easy to understand. Students just need to click on the play button to change the location tracking mode. Furthermore, they need to click on the bottom menu 'Account' to set the configurations and permissions.

Students 03 *"Settings is easy to configure. It is clear on how to change the location tracking mode and change the configurations."*
Students 10 *"The accuracy can be changed and the time interval can be controlled, which I think is great."*
Students 15 *"I am using Android 11, and just like android 10, device location access need to be turned on manual in settings. The instructions are clear, and I can just click the play button to change the location tracking mode."*

4. Opinion or suggestion for improvement No Location Tracking scenario

Initially, no location tracking is a default mode in our app. When the students want to change the location tracking mode, they just need to click on the Play button and select the option. This scenario aims to help users aware if they turn on the location tracking feature. Students need to click on the Stop button to turn off the location tracking feature. However, this scenario may cause the students to be confused since they can not find the "No location tracking" text. Therefore, a student suggests putting the information somewhere on the main screen about the current location tracking mode.
Students 04 *"I can't find 'No Location Tracking' option when I open the app."*
Students 12 *"I guess the default is 'No Location Tracking' because when I click on the play button, the available option is Automatic Location Tracking and Semi-Automatic Location Tracking. It would be better if there is information what my current location tracking mode.*

Some students suggest putting more information or notification to help them comprehend the apps. The data could be the last recorded activities or a message to remind users to track their activities in the Study Diary app.
Students 11 *"The filter always goes to the current day I open the app, so it looks like my previous activities disappear. The filter should be set to last recorded activity."*
Students 26 *"I would like more pop-up information to notify me to record my activities using the Study Diary app or maybe notifications about a quote of the day."*

5. Opinion or suggestion for improvement Semi-Automatic Location Tracking scenario

Some students prefer to have this option as Semi-Automatic Location tracking obviously gives control to students whether they want to record the visited place or not when

recording their daily activities. There are buttons in each visited location record, and students need to confirm whether they want to record the specific place.

Student 10 *"It asked me to confirm whether I wanted to include my location or not. I think I like this option."*

Student 22 *"This option gives me such authority to control whether I want to be recorded or not. I think this option is supposed to be the default."*

However, some students reported that the maps feature in the apps could not work properly as they expected. Students mentioned that the maps could not show the zoom-in of the current location, and it stopped unexpectedly.

Student 09 *"I could not check the location based on maps, so I don't know whether it tracks in the right place or not."*

Student 24 *"I think the tracker stops after several minutes. Because it only recorded places when I was on my way and only recorded 2 locations."*

6. Opinion or suggestion for improvement Automatic Location Tracking scenario

Overall students have no problem when using this automatic location tracking mode. Although at the beginning some students worry about data privacy, after use the app for period of time, some students feel that they contend with this feature since it less hassle in recording their location continuosly. Students also reported that they like the configuration settings which allow them to adjust the accuracy level and tracking time interval.

Student 09 *"This location tracking feature makes it easy for me to record where I am without any complications. It is quite helpful for me to think back on the things that I have done at that area."*

Student 11 *"I like the setting options since it gives me the impression that I have a bigger control in how the software operates."*

Students who use Android reported no significant challenges when activating Automatic Location tracking mode.

Student 03 "*Automatic tracking is working as it should."*

Student 11 *"I use Android 11, and I do not find any problem with the Automatic Location tracking."*

Student 19 *"It seems that this feature works properly. However, when I set the duration time into every 5 minutes, sometimes the app recording does not work exactly in 5 minutes. It takes longer."*

However, a student that uses iOS reported that the app does not work well since it stops unexpectedly.

Student 02 "I don't think this works well with my iPhone. It always stops tracking midway."

7. Opinion or suggestion for improvement Statistics scenario

Overall, students' opinions indicate that the Statistics scenario is easy to learn. The students mentioned that they comprehend the bar chart diagram containing personal stats and peer stats.

Student 06 *"Statistics can be found easily through the menu provided. I like using a bar chart because I can interpret the diagram easily."*

Student 26 *"It was easy. The option and the scenario are obvious and clear."*

Furthermore, a student suggests another feature to create students' groups on their own, so they can compare their performance with their circle friends, not always compare it to classmates cohort.

Student 23 *"I would like to compare with my own group of friends rather than to class cohort because I think I have nothing deal with my classmates. But comparing my performance with my circle could be more motivating. And, if you can do it, give a reward to students that win the competition."*

8. The benefits of using the Study Diary app

Some students reported that they feel activities tracking is the main feature of the Study Diary app. Using this feature, students can analyse their activities time behaviour to help them control what to do to stay productive.

Student 22 *"I can understand my studying tendency and how I manage my time. Because now I can track how much time I spend on different modules using the study diary app, I can control my time spent on modules to make it balance or empasize/focus on specific modules."*

Student 20 *"I have more stimulation to analyse my daily activities since I can see where I spent my time. It helps me to have more control about what activities that I need to do to be more productive."*

Student 13 *"I can easily track my studying activities in a week, and I can compare the behaviour from time to time."*

Students also said that using the Study Diary app helps them track progress from time to time to complete their goals. By knowing their progressions, students can allocate more time to achieve their priorities.

Student 05 *"I can track study goals digitally, so I know the progress, and it motivates me to reach my goal."*

Student 12 *"I began to understand how I tackle different assignments with different difficulty levels. Since I know my goal progression, I can focus and spend more time to achieve my goal priority."*

9. The challenges while using the Study Diary app

Mostly students that use Android mobile phone reported that the apps work properly so there was no unexpectedly crash. Therefore, they do not experience significant challenge while using the app.

Student 01 *"There is no challenge with the app. No crash issue at all. Duration settings could be better."*

Student 07 *"The app works properly. I do not have any challenges to use the app."*

Some students that used iOS mobile phone reported the unexpected error which drop their impression to use the apps. Some students also reported that their main challenge is they do not have the habit to record their activities and check it everyday.

Student 02 *"Some features still have bugs, so that I couldn't use them to the fullest."*

Student 26 *"My greatest challenge is I forget to record my activities. It would be great if there is a notification to remind me every day."*

10. The most important features of the Study Diary app

Some students mentioned that goal tracking and statistics quite helpful to give feedback for their self-reflection.

Student 05 *"I think goal-tracking and how many hours I have spent on doing something is kind of main feature of this app."*

Student13 *"I feel statistics is quite helpful since I can compare how much time I spend studying compared to others, and it might boost my motivation to study and compete."*

Student19 *"The statistics and the goal tracking bar."*

11. The least important feature of the Study Diary app

Students reported that the least useful of the app's feature that is the Automatic Location Tracking mode. The students' reason were related to privacy preference.

Student01 *"Automatic tracking is not that important if semi-automatic tracking is set as default. Users can easily control which location they want to show without hassle."*

Student07 *"I might forget to turn on automatic tracking at the beginning, but with semi-automatic on as default, I will notice that my location is well recorded, and I can pick which one to include."*

Student14 *"The full automatic tracking is not that important because the app keeps recording the location, which the users are not aware that the location tracker on their phone is still on. That is why I thought that this service may be annoying."*

7.5 Study Limitations

The first limitation in this study was recruiting many students in this research stage since we tested the app by installing it on students' devices. They might argue about privacy matters and their availability time. Some students do not trust the application since it was distributed as a beta version in App Store and Play Store. Therefore, the number of participants from the previous study were recruited and then extended using snowball sampling. The chain referral process helped reach populations that are difficult to sample with cost-efficient and simple processes. However, this sampling technique may cause sampling bias. The initial participants tend to nominate people they know well and share the same traits and characteristics. Therefore, the interpretation of the participants' opinions in this study is not meant to be generalised across all university students. The sample in this study may be only a small subgroup of the entire population. However, this study offers preliminary insight into students' responses after interacting with the proposed mobile app.

Second, this study involved mobile app implementation, which sometimes runs unexpectedly. These problems influence the students' feel when using the application during the trial period. Many factors cause app errors, such as poor memory management, device incompatibility, network issue, database contention, library functionality. However, these problems occurred due to technological implementation, which is not the focus of this study.

7.6 Discussions

What should be changed to improve the user experience of the product cannot be answered directly by only a quantitative measurement of user experience. The UEQ questionnaire makes it possible to know where improvements will have the highest impact. For an evaluated product, the UEQ shows a pattern of 6 measured user experience qualities. From this pattern, it is possible to make some assumptions about how to look for improvements.

The lowest score was the novelty (0.875), “above average”. Comparison with benchmark showed that 25% data in the benchmark are better novelty than our mobile app. Novelty assesses the feeling of creativity and product innovation which can interest users. Zeng et al. (2012) found that novelty was one of the main drivers for creativity, contributing to the intention of the user to keep browsing the website, revisiting it in the future and purchasing from it. Couger and Dengate (1992) considered factors that contribute to novelty: use of new technology to computerise something for the first time, use of a new algorithm, use of a new approach/method, and effective technology transfer. Furthermore, according to Beghelli and Jones (2020), to increase the novelty aspect of the software, we might want to add new functionality, extra functionality, new user interface, new user interaction, new user experience and latest technology infrastructure.

To improve the Novelty aspect in our study, we may consider user preferences mentioned in our previous study, such as adding gamification aspects to add a new user experience that makes students feel fun and engaging while using the apps. Another user interaction that we may add to boost the Novelty aspect was to add a feature to select the students to create a group comparison, as suggested by our participants in this study.

Furthermore, the Stimulation which scored 1.250 is also considered “above average”. Stimulation evaluates the user’s pleasure and motivation when using the product. According to the UEQ handbook, to increase the Stimulation score, we may improve the aspects of valuability, excitement, interest, and motivation. To improve the Stimulation aspect in our study, we may consider user preferences mentioned in our previous study, such as adding reward aspects to boost user motivation while using the apps. The reward is not always physical, but it can be a medal/badge in the app that may serve as a self-

reward. Hennessey and Amabile (2010) suggested that rewards can enhance intrinsic motivation and creativity when they provide helpful information in a supportive way, confirm competence, or enable people to do something they were already intrinsically motivated to do.

Proposing users to accomplish an action to obtain something that they find valuable is a way to keep them engaged with the app (Hodent, 2017). For example, when we click on a cookie, we gain another cookie, and if we experience this feedback as a positive reinforcer (reward), we will likely click again. Many apps use extrinsic rewards to encourage users to log in every day—for example, if they log into the app, they get a prize in the shape of a daily chest. Even if they did not want to play the app on a given day, they might, for example, want to receive some in-app currency (or other goodies) that they will be able to use later on. Therefore, we might use this kind of reward to improve the Stimulation aspect of the proposed mobile app.

This study has implications for practice based on present findings, showing that students have a positive user experience while interacting with the mobile app. Especially for students that tried the Android version, they responded positively and willing to install the application. It seems because the IOS version uses TestFlight to test the app, so the users need to install the TestFlight and follow some steps. This situation made some students from our previous study worry about installing the app on their mobile phones.

Overall, the UEQ score in pragmatic quality is good compared to the benchmark. It shows that the mobile app is easy to learn, efficient and predictable. It indicates that the students are already aware of QS technologies that may help them to improve personal or professional productivity. Generally, self-trackers want to control their lives by tracking and optimising their own lives. Regarding the hedonic quality, the UEQ score of our proposed app is “Above Average”. It means there is room for improvement. These results indicate that the app needs some improvement to make users feel engaged and fun while using the app. The students also perceive that the Novelty aspects of the app in this study are supposed to be increased by adding new features or new users interaction.

Although we previously discussed refining the design with the students, there are still weaknesses in the mobile app UX while it is tested in a natural environment. Some new

students involved in this study criticise the user interface and technical problem arise. There are suggestions for more information and notifications to know the apps' state. Below is the students' feedback for each tasks.

1. **User Registration**

   The User Registration page has a few controls that are simple for students to understand. A student only needs to enter their name, email address, and password to register. All of the students participate in this study said they succeeded on this task. Some student ideas are associated with the acknowledgement of users' actions. Toda et al. (2019) assert that acknowledging user activity is crucial since, in the absence of this dimension, students may experience confusion because their activities don't receive any feedback. However, sending acknowledgements that weren't carefully thought out could have unanticipated results (e.g., if students receive badges based on how quickly they accomplish things, they could rush through assignments without considering whether they did them correctly). Furthermore, to acknowledege new user registration, the program may typically send an email to a new user to confirm their registration. According to Calvaresi et al. (2021), the system may additionally give an unique token linked to a new user account to carry out the confirmation of a new user registration.

2. **Goal Tracking**

   Goal tracking page is a page where students can monitor their goal achievement through goal progression bar. In this page, students may also set a new goal or update existing goal. Overall students reported that task scenario in Goal Tracking is easy to complete. Some suggestions from students related to the way to input time which is in the form of clock.

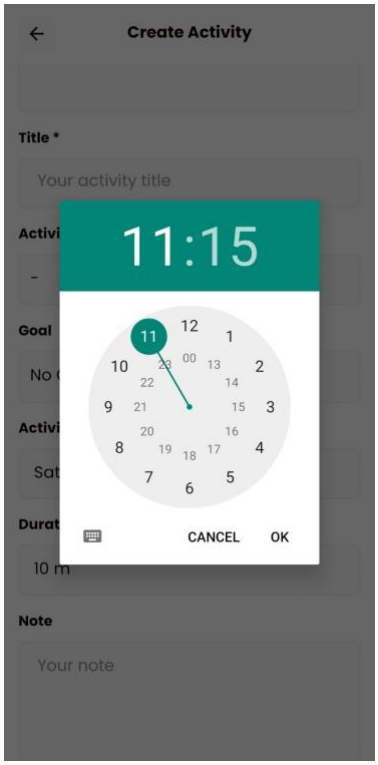


Figure 7.5 Analog clock with dual-ring

The interface design imitates the time representation used by analogue clocks to make it simpler for users to enter time or duration. According to Nikilovski (2019), when a product design follows real-world standards or utilizes skeuomorphism, it might be used as a tool to lead us to something that is much more basic and natural. Users should thus find it easy to understand and recall how the interface works.

However, students who participated in our study said they find it challenging to enter the time using an analog clock. They favor using a basic digital clock to set the time. Similar to this, Feldman et al. (2022) showed that participants, including those who were already familiar with 24 hour clocks, regarded all 24 hour analog designs to be strange and perplexing. They claimed that the majority of participants in their study found simple digital input to be the least confusing so they committed less mistakes.

3. **Settings**

Our design improvement for the Settings page is accessible via the Account button in the bottom menu. Because they don't need two hands and may be touched with only the thumb, UI elements at the bottom of the design are more accessible (Loeffler et al., 2021). According to our analysis, students seemed to find our Setting page to be straightforward and clear. This simplistic design aids pupils in learning and using the application effectively. According to Aguiar et al. (2020), a minimalist design with few visual cues and distractions can increase students' attention spans, cognition, and comprehension. They recommended creating an interface with few elements and material that is only necessary for the current task. Similarly, Valencia et al. (2022) suggested that minimalist design may decrease memory load, hence preventing cognitive strain.

4. **No Location Tracking**

By default, our app's location tracking feature is off. Students just need to click the Play button and choose a different option to change the mode for tracking their location. Students must press the Stop button to disable the location tracking function. Even though the design is straightforward, some students have trouble since they can't discover the label that says "No location tracking". Students recommended that the location tracking status information be displayed somewhere on the screen so that students are informed of their current location tracking mode. According to Zaina et al. (2021), if a UI element is not visible or is difficult to view, more cognitive effort is required to look for and compile it before usage, which might result in errors. Dease et al. (2021) also advise that some of the most important elements should be made more accessible to users so that they may assist users in completing tasks while they are using the program.

Additionally, some students suggested adding additional interaction with the app by sending out alerts with quotations of the day or simple messages to encourage students to use the apps. The usage of quotations or notes that are timed to display within an application is one kind of communication technique that may be used to establish and maintain relationships with users (Zhou et al., 2021). This information may be used to develop a relationship with the audience and increase brand recognition, both of which may lead to emotionally engagement.

5. Semi-Automatic Location Tracking

Users may have various intentions or preferences while using the software. The apps' flexibility may draw a wider range of users (Brunswicker et al., 2021). In our study, we provide students a variety of location tracking options to help them remember and log their study activities. Semi-automatic location tracking feature track all visited place, but in the end users need to select which location they want to record or discard. The semi-location tracking option satisfies most of students because it provides them a feeling of choice over how programs record their whereabouts. According to Rosala (2020), users should be able to simply enter their preference in the app in order to make sure they feel free and in control. Apart from UI design, students mentioned technical issues with the background location monitoring feature and how to evaluate its accuracy.

6. Automatic Location Tracking

People have used technology to help them remember things throughout history. Keadle et al. (2014) look at how geolocation information might aid adolescents' memory of events from the previous day (PDR). Using location tracking technologies and user input, we may create daily timeline activities that help in behaviour analysis as well as encourage self-reflection in time management. Additionally, Bjork & Bjork (2019) discussed how a certain location's knowledge may aid in the recollection of lessons about the "context effect." Similar to this, the students in our research expressed pleasure with the concept of logging a location to prompt them to remember their activities there in order to construct a daily timeline.

Moreover, in location tracking feature, we provide the app with the ability to track students' visited location based on their configuration input, such as the accuracy level and time interval to track the location. Overall students happy with this feature since it helps them to control how the apps track them when they want the option of automatic location tracking. Morever, students who use iOS platform reported the technical problem related with this feature.

7. Statistics

According to Barnet et al. (2019), UX designers should create mobile apps with intuitive navigation since they need greater ease of use and simplicity than desktop websites do due to their smaller screens, which make it tough for users to interact with and browse without challenges and mistakes. Moreover , Wu et al. (2021) highlight the significance of intuitive navigation to attract users' deep focus (i.e. cognition) and sense of control. Similar to this, our design considerations in subchapter 6.5 suggested using color contrast, a flat menu hierarchy and bottom menu to increase navigation visibility. As the results, students in this survey responded that they had no problem discovering the Statistic menu, unlike their response with our previous design.

According to student comments, the Statistics page's information is displayed in a clear bar chart, making it simple to understand. In order to compare their data across time, students also have the option of adjusting the time frame slider. The minimalist design in Statistics screen satisfy users since it is designed with less element to reduce users' cognitive load. As suggested by Mohanty et al. (2021), the cognitive load may be reduced by the user interface's simplicity and the little quantity of information shown on a single screen. Additionally, some students underline the extra feature they want, such as the ability to form a students' group or circle of classmates.

In user-centered design, designers employ a combination of tools, investigative approach (e.g., surveys and interviews) and generative approaches (e.g., group discussions) to establish a knowledge of user's needs (Goel et al., 2022). UCD bases its initiatives on a clear understanding of the people, tasks, and surroundings. The approach is intended to collect and address the whole user experience. UCD is an iterative approach in which designers and other stakeholders concentrate on the users and their requirements throughout each step of software development. Moreover, UCD also includes iterative UI design. According to Lewis and Sauro (2021), conducting iterative UI design significantly improves the products' usability (Lewis and Sauro, 2021).

In general, our study reveals that after design refinement, students had more positive impressions of the UI design and the application content. Students also noted that the application somehow fulfil its aim to assist students in analyzing their time-spending

behavior. Furthermore, there is still a need for improvement in terms of good user interface design, additional features, such as gamification and customizable students' groups, and technical factors, such as location tracking as background service technology and its precision.

Chapter 8. Conclusion

Chapter 8 connects and elaborates on the preceding chapter's key conclusions. In Chapter 4, the perspectives of students on several data sources for self-reflection on time management are discussed. The design considerations and guidelines for self-reflection time management apps for students are presented in Chapters 5 and 6. This chapter's goal is to overview the significance of this study's key findings in connection to the dissertation's research questions. After that, the theoretical and practical contributions are highlighted, followed by limitations and future research directions.

8.1. Summary and Discussions of Main Findings

8.1.1. Students' views regarding data privacy and how they want to disclose the data from different sources outside a VLE in their time management apps

The first research question aims to understand students' views on data sensitivity and their willingness to disclose the information to others. Many data sources derived from activities outside VLE may support students' self-reflection in time management. Our study explored various data sources, ranging from data on students' activities on campus and online and their physical activities. Students may think some data sources are sensitive, so they might be reluctant to share them with others.

Traditional practices about information disclosure among undergraduate students have sparked accusations that "young people don't care about privacy" (Hargittai & Marwick, 2016, p. 3739). However, research on the privacy practices and expectations of university students indicates that although students care about their privacy, their perspectives, expectations, and behaviours vary depending on their context and sociotechnical aspects (Wu, 2019). According to some experts, there is a "privacy paradox" where people frequently reveal sensitive information while claiming to care about their privacy (Tsai et al., 2020). According to other studies, this apparent contradiction can be explained by interfaces that are meant to deceive (such as dark patterns; Waldman, 2020), acquired helplessness (Hargittai & Marwick, 2016), or even a false sensation of control (Brandimarte, Acquisti, & Loewenstein, 2013).

Innovation in social networking sites, mobile technology, and wireless connectivity encourages fresh perspectives on communication theory, particularly in the field of self-presentation. The term "self-presentation" refers to strategies used to display one's image while limiting information disclosure (Goffman, 1959). Vitak and Kim (2014) researched disclosing information among graduate students. As their sample was comprised of graduate students, many of whom had befriended faculty members and previous or current students, the participants were highly aware of their self-presentation online. They were concerned about an existing or potential audience viewing their content. Therefore, they want to portray their image as a professional when self-disclosing their information online. Similarly, Hong et al. (2020) reported that to project a favourable image of oneself in computer-mediated communication contexts, people frequently build making a nuisance of their personalities

According to the questionnaire result in section 4.3.2, undergraduate students tend to share their data identifiable with the tutor for library activity information and class attendance. Undergraduate students also tend to anonymously disclose that information to the university. Regarding web browsing history, undergraduate students would like to anonymously reveal their time spent accessing websites that may support students' performance, such as communications/scheduling, reference/learning, news/opinions, design/composition, and utility website to the university.

Furthermore, the Master students (section 4.3.3) and PhD students (section 4.3.4) are more sensible when disclosing their information to others. They prefer to share their data anonymously rather than with their identity. Master students are generally happy to share their data anonymously with tutors, university, and peers despite how sensitive the information is for them. PhD students are likely to be more cautious when sharing their data with others. There is a tendency for PhD students to not share the data items at all with tutors, university, and peers if they consider the data to contain sensitive information. However, when the information is considered less sensitive but valuable for self-reflection, PhD students tend to share it anonymously with their tutor and the university.

According to our questionnaire results, university students are likely aware of their data privacy and online self-presentation. Students have the inclination to reveal information about their performance and productivity to their tutors or universities. When students want

to present themselves in the best light possible, it could be to make them feel better about themselves or to influence how others perceive them. Students also may use self-presentation to reinforce a desired identity for themselves as part of identity construction (Kawamoto, 2021). Positive pressure from portraying their positive image may help them stay accountable to commitments in ways that would be difficult to achieve on their own.

Despite the sensitivity of the information, Master's students in our study seem content to share their data anonymously with the university, whereas PhD students are more circumspect about sharing it with others. When the data is generally considered less sensitive but still useful for self-reflection in time management, PhD students typically share it anonymously with their advisor and university. The way students want to share their information anonymously, according to Wu et al. (2022), is because it helps them avoid social risk. Similarly, Dyussembayeva et al. (2020) reported that individuals are more comfortable disclosing personal information when the surrounding environment is private or anonymous. They also explained that the level of risk associated with self-disclosure influences people's willingness to reveal their identities.

Cho et al. (2018) found that users' intentions to disclose information were influenced by their perceptions of the privacy risk and their values, which is known as the privacy calculus. Cho et al. (2018) claim that students' perceived privacy concerns diminished the perceived value. In addition, the perceived value had a greater impact on information disclosure than perceived privacy concerns. Therefore, students are more likely to provide their information if they believe the benefits outweigh the risks to their privacy. This present study supports the conclusion of Cho et al. (2018) that students' intentions to disclose information are influenced by their perceptions of privacy and benefits. Students' reluctance to share their information with others is reduced by their concern for privacy. For instance, all of the student groups in our study were determined to have less sensitive information when it came to class attendance and library access and loans. Therefore it is not surprising that the majority of students tend to share this information with others. Despite the fact that they view this information as less sensitive, undergraduates tend to keep it to themselves. The reluctance of undergraduate students to share information with their peers may stem from their perception that doing so is of little worth.

8.1.2. The data sources expected by the student to be useful for their Time Management app

The second research question aims to investigate students' opinions of the usefulness level of each data source. We investigated the data sources from outside the VLE that are considered to provide valuable insights to help students' self-reflection on their time management.

According to section 4.4.2 explanation, the undergraduate responses with the highest positive values are class attendance report, date, time, and location of work, exercise, and study. The second-highest positive values are the amount of time spent on Social Networking websites, followed by the date, time, and study location. The frequency of visiting the campus library, frequency of login to the online campus library, and frequency of book loans from the campus library are all considered to be less useful data sources by more than half of undergraduate students.

Although some literature suggests that library interaction may increase students' academic engagement (Sakirudeen and Sanni, 2017) and positively correlate with their academic performance (Zhao et al., 2020), the majority of undergraduate students in our study believe this information is less useful for self-reflection in Time Management. The majority of undergraduates believe the most valuable data sources for their Time Management app fall into three categories: class attendance, self-declared and tracker-app data, and web browsing history, particularly the time spent accessing social networking sites.

The class attendance report is helpful for undergraduate self-reflection in Time Management due to the nature of undergraduate course delivery, which requires class attendance. Numerous studies have demonstrated a positive relationship between class attendance, student engagement, and academic achievement (Zhu et al., 2019; Pinter et al., 2020; Sekiwu et al., 2020). Although Grey and Gordon (2018) stated that class attendance has no effect on student's academic performance, students in our study, particularly undergraduates, believe that class attendance is useful information for their self-reflection in Time Management. Students at the undergraduate level in this study recognize class attendance as useful information may because class attendance is perceived as more social and as enhancing feelings of presence and interaction skills (Fitter et al., 2020).

Furthermore, 91% of Master's students in our study consider that knowing the date, time, and place of their studies helps them reflect on their own behaviour. The high ranking of this data source could mean that students need a study journal to help them keep track of their study time. Similar to undergraduate students, Master students affirm that class attendance reports are also crucial for their self-reflection in time management. In contrast to undergraduates, Master's students are more likely to view time spent on Reference/Learning websites as useful information than time spent on social networking websites. Moreover, more than half of the Master students in our study consider that Time spent accessing Entertainment websites and Shopping websites as less useful data sources for their self-reflection in time management.

According to Aust et al. (2019), the negative effects of students' screen time include distraction, obsessive habits, and a factor that contributes to poor sleep hygiene. In addition, they described the relationship between screen time, dependency, and necessity. Therefore, self-control to restrict screen time was constantly suggested as a solution to screen time's harmful effects. While some authors have suggested the need for external interventions to help students better manage their time and the cognitive load of studying (Sepp et al., 2019, Moezeh et al., 2019), participants in the study conducted by Aust et al. (2019) identified self-directed ways they and others attempt to exercise self-control.

In addition, the Master's students who participated in our study favoured study logs, work logs, class attendance, and time spent in Reference/Learning over data sources that may reveal some diversions, such as Time spent visiting Entertainment and Shopping websites. Despite the fact that screen time is also potential data for students to reflect on their time management, our survey results indicate that Master students prefer more information that represents students' productivity. Alvarez-Sainz et al. (2019) underlined the usefulness of journaling in improving students' time management and productivity. Writing goals and activity records in a time-use format is a time management skill that supports students' self-reflection on their time usage behaviour (Nückles et al., 2020).

Of the PhD responses, our study reveals that 100% of PhD students consider the time spent accessing reference/learning websites as a valuable data source for their self-reflection. They also believe that the date, time and location of study and work are essential to support

their learning analytics. Furthermore, we may notice that mainly PhD responses consider data sources are low-rank useful information, such as time spent accessing blogging, Twitter, shopping websites, entertainment websites, etc. The PhD responses in our study are similar to Master responses in terms of their preference to include information that reflects their academic performance rather than the time that reflects the distraction.

To sum up, our survey findings indicate that undergraduate and master students are likely to put the class attendance reports as highly useful information. This indication makes sense since both study-level have more class meetings than PhD degree-level. This study also indicates that undergraduate students are likely to consider the time spent accessing social network websites as highly useful information. However, most Master and PhD students believe that time spent accessing social networks is lower-rank of useful information for their self-reflection. These cohorts, Master and PhD students, are likely to consider data related to activities that can increase students' productivity and performance as useful information. Those activities are, for example, time spent accessing online campus libraries, news/opinion websites, reference/learning websites, etc.

8.1.3. Students' preference regarding the UI design, navigation and content of students' time management app

Simple sketches, mockups, or wireframes are frequently used in the user-centred design process for some or all of the designs (Saparamadu et al., 2021). This makes for a significantly more efficient and cost-effective design procedure than constructing the final product and then having to make costly modifications if it does not match user requirements. The needs of users must be at the centre of the design process of an application (Aguirre et al., 2020). To capture requirements from students, we conduct group discussions to collect their opinions regarding the design of mobile apps. We use screenshots of similar application displays to help students get immersed in our problem space. The focus groups showed some aspects of designing the app that did not arise in the previous online questionnaire. Audio recordings during the session were transcribed, and suggestions from students were collected and interpreted in a thematic analysis. Moreover, participants were also asked to design app screens using paper and pencil in this stage. The participants' screen designs represent the expected features of the mobile app. The expected features by most students are then likely to be implemented. In our discussion, students

who were initially inclined to use automated technology to analyse their time changed their perception. There are concerns about the app being used to control the students' lives and harm their privacy.

There are four themes found in the data analysis for this study: location tracking, data sharing, gamification, and other expected features. The design considerations found in this study are related to each theme. Table 5.3 summarises the design consideration related to time management apps' content for students.

More people are inevitably accepting location-tracking technology, despite scepticism about its accuracy (Yong et al., 2019; Shubina et al., 2020). In numerous ways, location-tracking technology benefits humanity. In health and fitness apps, it may identify the user's physical activity and location, such as how far they have run or cycled, as well as their location and path. However, it cannot be denied that an individual's location information is vulnerable to misuse. Although location-tracking technology can make people's lives easier, it raises privacy concerns over the storing, transmission, and disclosure of users' positions and identities (Tsai et al., 2009). Chowdury et al. (2020) reported that location or proximity data paired with personal data could be damaging, which could reduce users' trust in apps.

The first design consideration is to best present the flexibility of location tracking features to students. Regarding the location tracking feature, the flexibility of selecting location tracking mode is needed since the students' preferences could be situation-dependent. For example, in a few situations – when users enter certain sensitive areas – they want the information about their location to remain private. Furthermore, since it relates to users' privacy, the tracking mode selection should be clear and straightforward to help students become aware of the options.

Furthermore, in our group conversations, we have also considered the potential of users sharing their data in exchange for peer or community support. Students in our study appeared more comfortable disclosing anonymous information than personally identifying information. They believe that the manner in which they distribute information should correspond with its objective. When the university needs to analyze student behaviour in order to build strategies or rules, it may suffice to observe the trend of the students'

anonymized data. According to Hollenbough (2021), the anonymity of online users distinguishes them from their offline identities. The greater the degree of anonymity of online users, the fewer restrictions offline users must adhere to while presenting themselves.

The second design consideration for students' time management app is an aspect related to the data-sharing mechanism. Students in our study generally feel that the data of students' activities and duration are appropriate to be shown to the personal tutor/university, unlike location data which is considered more private. Furthermore, the data on students' activities and duration could be shared as anonymous information (in statistics) to help the university get insight into their students' behaviour. This anonymity is consistent with our earlier survey results showing that most students prefer to submit their information in an anonymous manner.

The third design consideration for students' time management app is related to increasing the students' motivation to use the app using gamification. Most students want to avoid using a leaderboard feature to compare their personal stats with their peers. Instead, using a graphic/chart to compare students' stats with the average peer stats will be more helpful. Moreover, since students have their own goals/targets, the goal achievement chart is essential for knowing their progression towards the goal.

Although some studies (Wang et al., 2022; Dumas et al., 2022) highlight the value of leaderboards as game elements, Cao et al. (2022) report that users exhibit more negative emotions and are less engaged with leaderboards when the tasks are tough in their gamified scenario. They found that by making task difficulty less challenging, the leaderboard can effectively play a role in enhancing learners' motivation and emotional well-being. Moreover, Raftopoulous (2020) asserts that people today are more sensitive and disapprove of leaderboards. This condition is also in line with our research, which indicates that students do not want leaderboards in our gamification scenarios.

The fourth design consideration relates to features students expect from their time management app, such as schedule management, file storage in the activity description and goal tracker. Furthermore, through the participants' screen design, some expected features are comparing target and actual activities, comparing time spent doing certain activities or

visited places in specific periods, daily timeline, and badges/medals/scores. Our findings are consistent with Wacjman (2019), that emphasizes the use of calendars and schedules in daily life for time management application. The schedule management feature helps users to stay organized and keep stay on track to accomplish their tasks. According to Pinke et al. (2021), setting goals and monitoring their progress helps users to combat procrastination to improve time management skills.

Furthermore, in this study, we explore students' preferences in UI design, which includes the layout and navigation of the app that they prefer. We used Adobe XD to create a prototype based on the design principles outlined above and the students' sketch designs. The usability of the prototype was then assessed by each student separately through remote testing. Below is an overview of the details of the design guidelines for user interface design that were covered in sub-chapter 6.5.

Bar charts show contrasts between groups or other discrete data (Bertini et al., 2020). Longer bars denote greater values, and each bar represents a summary value for one discrete level. Users may easily see whether they have achieved the goal by looking at a progress bar chart with full and empty boxes (Kang et al., 2023). Our findings suggest that the goal progression bar chart should include numbers to help users easily recognize their goal accomplishments. We provide details on the number of hours attained and goal-target hours in our design refinement. This improvement is related to Babich's (2018) recommendation to avoid relying solely on colour to communicate information. In order to make sure that users can engage with an interface, he suggested incorporating other visual indicators.

Additionally, our findings recommended reducing the amount of information on a single screen. This recommendation is in line with Babich's (2018) advice to limit the number of content and interface elements. As Alsswey and Alsamarraie (2020) indicated, maintaining the simplicity of app design is crucial since it positively corresponds with users' intentions to utilize the apps. Mohanty et al. (2021) also pointed out that the cognitive load might be minimized by the user interface's ease of use and the limited amount of information on a single screen.

Regarding the chart that is displayed in an application, we advise the use of a diagram that is easily understood by users. According to Cisneros (2021), spider charts can be visually

appealing and encode a great deal of information in a very small space. Nevertheless, some audiences may require additional effort to comprehend the chart. In order to assist the audience, Cisneros (2021) suggested adopting a more popular chart, such as a bar chart to compare discrete data.

In addition, our research suggests acknowledging users' actions by giving them meaningful feedback after they interact with an app. The communication channel may consist of modal warnings, confirmations, or push notifications (Lupanda and Rensburg, 2021). In addition, Babich (2018) advised that the presented information should be valuable, cover what users require, and be delivered at an appropriate moment. Users may become irritated if the application displays too many alerts and push messages.

Our next recommendation is to provide symbol buttons with appropriate short text labels to improve the clarity of the buttons' actions. According to Ejaz et al. (2019), the predictability of the user interface is crucial for users to comprehend and feel secure when clicking a button. The availability of clear labelling lowers users' initial irritation while interacting with new applications. Moreover, Soni et al. (2019) suggest a minimum font size of 14 points for the label (0.5cm).

Regarding app navigation, we suggest using colour contrast and a flat hierarchy to highlight it to users. Lupanda and Rensburg's (2021) recommendation is to put top-level menus in mobile apps because it may make it easier for users to interact with the top-level menu with one thumb. However, Ahmad and Ibrahim (2017) argued that a flat hierarchy is preferable on smartphones since it takes fewer steps. They suggested implementing a shallowly structured menu as opposed to a deep hierarchy. In the same way, we recommend using the bottom menu instead of the menu at the top of the screen. This is because the bottom menu is laid out horizontally, so more menus are visible to users without them having to click on them.

Our final UI design recommendation is to always strive to simplify the steps required to achieve a given task. The user experience is improved by a pleasant user interface, which places the highest priority on powerful interfaces while maintaining a minimalist design (Sushra et al., 2022). According to Sandesara et al. (2022), minimalism should be adhered to while designing a mobile UI that is both simple and effective.

8.2. Reflective Discussions

In the world we live in, everything changes tremendously quickly, including new products, professions, and methodologies. A clear pattern is already emerging: Businesses no longer push their products onto the market (Abdollapouri et al., 2020). Instead, they focus on making a product more user-centric so that they may finally provide the customer with what they want. This tendency can be observed in institutions that promote innovation, such as large firms, business schools, and universities (Guaman-Quintanilla et al., 2022). We can see that companies like Duolingo[23], Trello[24], AirBNB[25], Spotify, and Stanford University (Qu et al., 2022) have embraced user-centred design in their initiatives.

My doctoral dissertation looks into a user-centred design for time management apps for students. We employ mixed methods research in this study, which combines qualitative and quantitative techniques. Because the app aims to support students' self-reflection on time management, we integrated students from the beginning of ideation to app review, making sure to always take their opinions and requirements into consideration. In this study, we don't impose our ideas on the students; instead, we use their comments to help us create applications that are acceptable for their requirements. For instance, in this study, we gave students the option to decide the data they wanted to include in their time management software. We offer a variety of data sources that may be divided into five groups: library access and book loan data, class attendance data, social network data, self-declared and tracker-app data, and social network activity data. We evaluate how sensitive the information is perceived by the students, whether they would prefer it to be disclosed in an identifying or anonymous form, and how well the information might enhance their self-reflection on time management.

Some data sources that we provide are considered as information that represents students' productivity in academics, such as frequency of login to the online campus library, time spent accessing the online campus library, class attendance over a certain period, time spent on accessing Reference/Learning websites, etc. Some data sources reflect distraction for students' time management, such as time spent accessing entertainment, shopping, or social

[23] https://www.duolingo.com
[24] https://trello.com
[25] https://www.airbnb.com

network websites, timestamp and location of entertainment logs, and time spent accessing Facebook, Youtube, Twitter, etc. According to our survey result, undergraduates, Master's students, and PhD candidates appear to hold different viewpoints on data privacy and which information is most helpful for self-reflection on time management.

Undergraduates consider class attendance records, work logs, exercise logs, study logs, and time spent accessing social networking websites as the top five data sources that are most helpful for self-reflection on time management. Based on undergraduate preferences, it is clear that the students value both information that may show academic productivity and information that may reflect study distraction as helpful data for self reflection. Study logs, class attendance, work logs, time spent using Reference/Learning websites, and the online campus library are considered to be the five most helpful types of information by master students. The fact that Master's students tend to consider information that reflects academic productivity for self-reflection on time management is similar to the decisions made by doctoral students. PhD students regard study logs, work logs, frequency of book loans at the campus library, time spent on Reference/Learning, and News/Opinion as the most useful information.

Time management abilities consist of time planning, scheduling, and goal management (Wolters and Brady, 2020). For instance, a student might set out time each week to read articles or finish assignments. Students must prioritize their learning objectives and be mindful of deadlines and the amount of time needed to complete each task (Anthonysamy et al., 2020). Although there is no agreement on its primary elements, academics often define time management as a multifaceted process that includes goal setting and prioritizing, short- and long-term planning, organizing or allocating how time is utilized, workload anticipating, and tracking how time is actually used (Malkoc and Tonietto, 2019; Dekker et al., 2020). Effective time management is demonstrated by a person's capacity to spend their time effectively and in a way that both advances the pursuit of important goals and also avoids procrastination, distractions, or other time-wasting activities, even in the face of changing situational demands (Jawad and Hamidi, 2022; Romero-Pérez and Sánchez-Lissen, 2022).

Some academics assert that students' misuse of time has an impact on their academic achievement and well-being (Hill et al., 2022; Wolters and Brady, 2020). Unsurprisingly,

university students spend a significant portion of their waking hours doing things that are either unrelated to their academic commitments or that will likely take them away from achieving their essential personal goals. For instance, university students commit a substantial amount of time to social networking, video watching, computer gaming, and other social or recreational activities that are unlikely to improve their academic performance (Astatke et al., 2020). Students may also show these behaviors while in class. In addition, many students struggle to manage their study time, keep up with their assignments, or even attend class consistently (Alamoudi et al., 2021; Zhu et al., 2019). This circumstance demonstrates that information on how students spent their time and participated in activities that may divert them from academic responsibilities and personal goals may be useful for students' time management self-reflection.

Although other researchers discovered that the time that reflects time misappropriations is valuable for students' self-reflection in time management, the majority of students who took part in our study valued data sources that may assist students in reflecting on their time dedicated to pursuing academic goals. Similarly, several empirical research shows a positive connection between improved or more efficient time management and measures of study time, engagement, and learning and achievement (Wolters and Brady, 2020; Anthonysamy et al., 2020). Spending more time studying, as expected, is connected with higher academic performance, especially when prior ability and engagement quality are included (Müller and Mildenberger, 2021). As a result, our study then focused on exploring more about time management, which helps students to monitor their time spent on academic activities and no longer discusses the social media or activities that may distract students from their academic responsibilities.

In addition, we provide a gamification scenario in this study to encourage students to use the app. In the gamification scenario, participants who had already accomplished their goal would be given badges. Participants who completed every daily goal in a week earned seven daily stars, each indicating a daily reward for accomplishment. For completing a weekly goal, participants were given one star each week. The majority of participants in the usability testing were not pleased with the gamification scenario. Some of them think the situation isn't very imaginative or entertaining. The participants expect that the gamification scenario able to bring more enjoyment while using the application. Other

participants stated that they found the goal progression bar chart to be more informative than the badge section and chose to view it instead.

According to Neupane et al. (2020), some gamification mechanisms are challenges, points, badges and stickers, leaderboards/scoreboards, performance charts, levels, in-app currencies, constraints, and journeys. In addition, we included challenges, badges, and a performance chart as game elements in our design. Challenges are tasks that students must complete in order to earn badges. In our design, 'Challenges' corresponds to 'Goal,' which is independently determined by each student. When a student achieves a goal, he or she receives a badge, which in our design, appears in the form of a daily or weekly star. Performance charts compare the current performance of a student to his or her historic performance. In our design, the students can modify the weekly period to monitor their progress over time.

The reason why students do not favour our gamification scenario is probably that the user story narration of our program is less enjoyable than those of best-practice gamified mobile apps like Duolingo and Forest. The storytelling narration of those apps, Duolingo and Forest, is captivating, which make user unaware that they improve their productivity while enjoying the gamification scenario. According to Prakasa and Emanuel (2019), to create an attractive narrative of the gamification scenario, we could add some storyline when introducing the users to the tasks they need to accomplish. Then, instead of simply describing the situation, let the characters in the application tell the story with a dialogue in the bubbles. Adding a difficulty level or role that users can choose is also part of how to make the storyline more creative and fun. Further study could be carried out to improve the compelling narrative and gamification scenario.

8.3. Limitations and Future Research Directions

There are limitations in our study, some of which require further investigation. First, the small number of total participants in our online survey. Most of them are Newcastle University Business School Master students, which does not provide equal representation of different disciplines. The recruitment was done by putting announcements in students' public spaces, sending emails to students and putting announcements in students' societies' media. To increase the response rate, we also give vouchers to respondents. However, the

participation rate from students at Newcastle University is still low. Therefore, the sample in this study may be only a small subgroup of the entire population of students at Newcastle University. In our study, the imbalance of the students' department also may cause a bias of precise conclusion.

Second, the participants in this group discussion are ideally those who can join all research stages, so they know from the beginning about the idea of this research. However, most of the participants are Master students, so they finished their education at Newcastle University in one year and returned to their home country. Another problem arose when we needed to test the app using students' devices. They might argue about privacy matters and their availability time. Some students do not trust the application since it was distributed as a beta version in App Store and Play Store. We recruited the number of participants from the previous research stage and then extended it using snowball sampling to overcome this problem. Nevertheless, this sampling technique may cause sampling bias. The initial participants tend to nominate people they know well and who share the same traits and characteristics. Therefore, the sample in this study may be only a small subgroup of the entire population of students at Newcastle University.

Third, the interpretations and opinions of the participants in our research are not meant to be generalized across all education-level students. Instead, this research offers preliminary insight into how some university student populations perceived the mobile app to help self-reflection during their study at the university. The groups were homogenous, based on the participants' educational status and age. Another limitation we faced was measuring the user experience using a mobile app that needs to be installed on students' devices, which sometimes runs unexpectedly. These problems influence the students' feelings when using the application during the trial period. Many factors cause app errors, such as poor memory management, device incompatibility, network issue, database contention, and library functionality. However, these problems occurred due to technological implementation, which is not the focus of this study.

Our study has investigated the students' perceptions of the data sources from outside VLE in learning analytics applications. We explored students' privacy preference and their willingness to disclose the information from each data source. The student's perceptions of the data usefulness and its sensitivity level are also studied. The privacy aspect and the

student's willingness to disclose their information can be further investigated. The mobile app design in our study can be developed further to have a feature to create student groups (friend circles).

Future research may analyse the students' behaviour in disclosing personal information to their community circle/students' group. Some apps such as Duolingo, Travel Buddy[26], Freeletics[27], and Strava[28] includes the has a social feed where people can follow each other and compare their performances. The community motivates individuals to help one another or compete to achieve the group mission. It may demonstrate the effectiveness of peer pressure in improving user app engagement.

In addition, future research can investigate ways to create more creative scenarios in gamification contexts. We may add a plot, objectives, and characters to the program. Giving consumers the option to select their own difficulty level or role is another way to make the plot more imaginative and entertaining.

[26] https://www.beatravelbuddy.com
[27] https://www.freeletics.com
[28] https://www.strava.com

Appendix A. Ethical Approval

18-CAH-025

SAgE Faculty Ethics Committee
Ethics Application Pro-forma

Applicant Name:	Andharini Dwi Cahyani
Applicant email:	a.d.cahyani2@newcastle.ac.uk
Academic Unit	School of Computing
Supervisor email (if available)	Lindsay.marshall@newcastle.ac.uk
Category	Postgraduate Research (PhD)
Project Title:	Personal Learning Analytics Application for Students
Start / End Date	01/05/2018 to 31/10/2019
MyProjects Reference (if available)	
Reviewer 1 Name: Date sent: Date comments received:	 Dana Ofiteru 11/06/2018 12/06/2018
Reviewer 2 Name: Date sent: Date comments received:	 Ahmed Kharuffa 01/05/2018 10/05/2018
Date comments provided to researcher:	21/05/2018 and 12/06/2018
Date researcher confirmed amendments made:	17/07/2018
Faculty final approval date:	10/08/2018
Notes	
Follow-up queries	
Later amendments requested from applicant: Details: Date requested: Approved? Date approved:	 Yes 10/08/2018

Approved / ~~Not Approved~~ by the SAgE Faculty Ethics Committee

Signed by Dr Patrick Degenaar (Chair)

.....

Date: 10/8/2018

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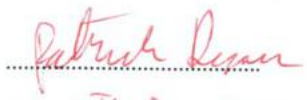
18-CAH-025

SAgE Faculty Ethics Committee
Ethics Application Pro-forma

Applicant Name:	Andharini Dwi Cahyani
Applicant email:	a.d.cahyani2@newcastle.ac.uk
Academic Unit	School of Computing
Supervisor email (if available)	lindsay.marshall@newcastle.ac.uk
Category	Postgraduate Research (PhD)
Project Title:	*Personal Learning Analytics Application for Students*
Start / End Date	01/05/2018 - 31/10/2019
Reviewer 1 Date sent: Date comments received:	Dana Ofiteru 11/06/2018 12/06/2018
Reviewer 2 Date sent: Date comments received:	Ahmed Kharuffa 01/05/2018 10/05/2018
Date comments provided to researcher:	21/05/2018 and 12/06/2018
Date researcher confirmed amendments made:	17/07/2018
Faculty final approval date:	10/08/2018
Later amendments requested from applicant: Date requested: Approved? Date approved:	Applicant would like to request an extension to the ethical approval as original project end date has now expired and the project is now going to end on 31/10/2023. Applicant has confirmed via email that no changes will be made to the project. 20th November 2019 Yes Informal approval granted 20th November 2019 Patrick will formally sign off on 19th December 2019

Approved / Not Approved by the SAgE Faculty Ethics Committee

Signed by Dr Patrick Degenaar (Chair)



Date: 19th Dec 2019

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Appendix B. FGD Session Plan

Aims :

- To understand students' differences perception regarding location tracking, data sharing with others, and gamification.
- Explore and get in-depth and nuances of opinions

Time : 60 – 80 mins

Steps	Time	Materials
Step 1: Welcome The facilitator welcoming participants - Welcome - Participants assents - Group agreements (debriefing)	5 mins	Welcoming Script Participant consent form Guidelines/group debriefing
Step 2: Opening questions Facilitator presents the slide Participants observe the installed app and answer individual questionnaire	20-30 mins	Handout Observation to installed apps: Hypertrack Swarm ATimeLogger
Step 3: Main Questions Discussions of personal learning analytics for student. Each question is designed for 7-10 mins discussion.	30-40 mins	List of main questions
Step 4: Closing Say thanks and give the giftcard	5 mins	

WELCOMING SCRIPT

Welcome to this Group Discussion.

Introduce moderator

Our topic is designing personal learning analytics app for students. This app is aimed to help students to keep their study/work record so students may see their behaviour/pattern.

The results will be analysed and used as design consideration in building the mobile apps for students.

You were selected because you are students at Newcastle University and willing to join this group discussion.

GROUP DEBRIEFING SCRIPT

Guidelines

No right or wrong answers, only differing points of view

We're tape recording, so one person speaking at a time

We're on a first name basis.

You don't need to agree with others, but you must listen respectfully as others share their views

We ask that your silent mode mobile phones. If you cannot and if you must respond to a call, please do so as quietly as possible and re-join us as quickly as you can.

My role as moderator will be to guide the discussion. Talk to each other participant.

The agenda for discussion:

1. Introduction
2. Individual questionnaire
3. Group Discussion
4. Closing

PARTICIPANT CONSENT FORM

Project Title: Personal Learning Analytics Application for Students

---

Researcher: Andharini D Cahyani

School of Computing, Newcastle University

a.d.cahyani2@newcastle.ac.uk

	Please Tick
1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.	☐
3. I understand and agree to take part in the above study.	☐
4. I agree to the use of anonymised quotes in publications	☐

Name of Participant	Date	Signature
_____	_____	_____

HANDOUT

Aims: To make participant understand the context of this research and can senses the similar app to get the idea.

Designing Mobile App for students

Agenda

- Introduction
- Individual questionnaire
- Group discussion
- Closing

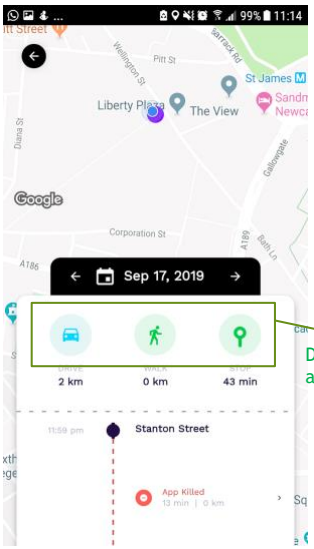
Introduction

WELCOME

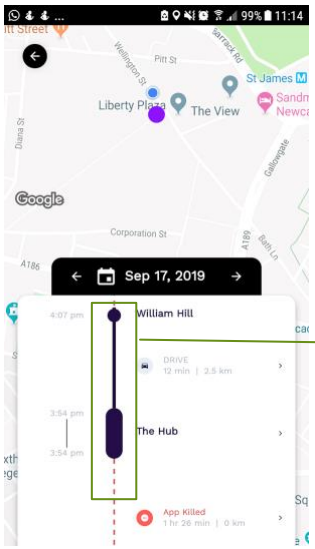
PARTICIPANT CONSENT FORM

Mobile app: Automatically detection

- Automatically figure out trips and stops in the life of the user
- The information presented may be sensitive for some people so they use it for their own record, not to share it with others
- E.g.: Hypertrack



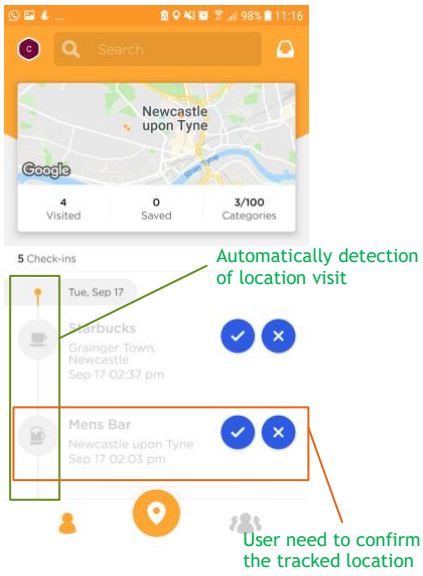
Daily summary activity

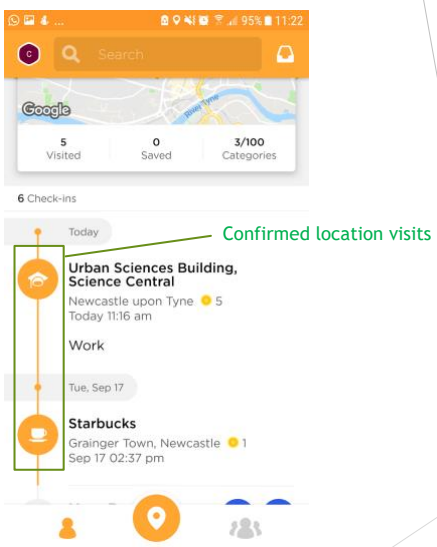


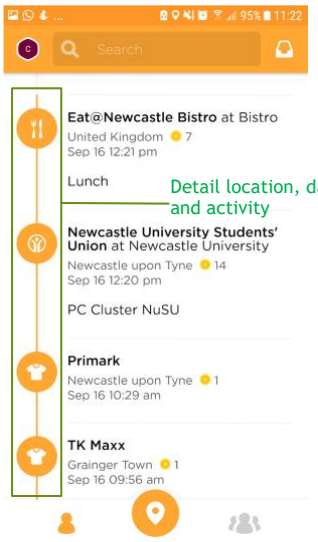
Detail location, time and activity

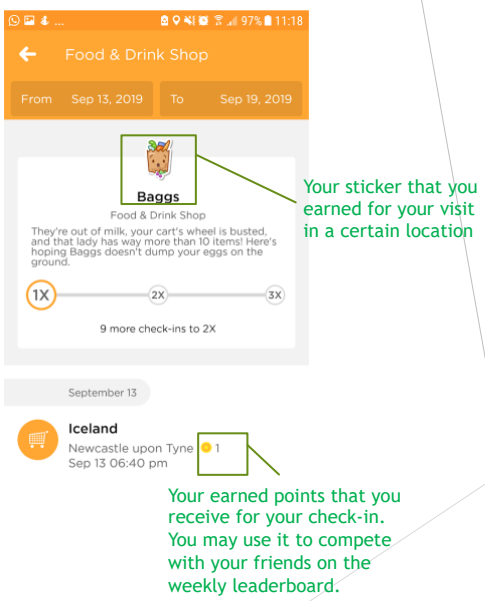
Mobile app: Semi-Automatically detection

- Automatically figure out user's stops but user need to confirm it as a visits to record the activity
- User get rewards (badges/sticker and coins) for their check-in(s)
- Connecting people through social media
- E.g.: Swarm by Foursquare



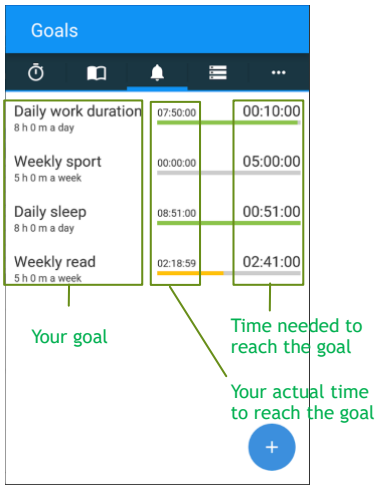


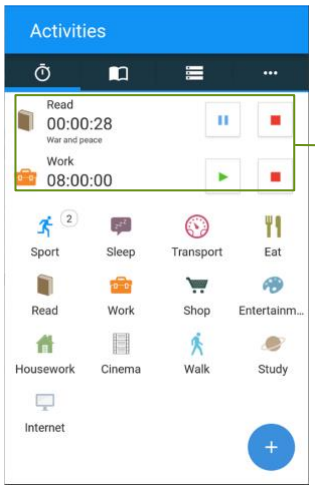


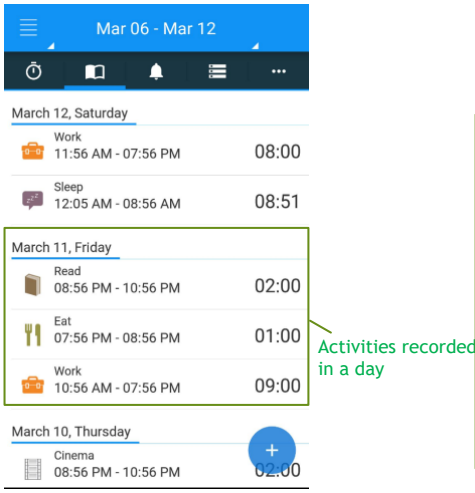


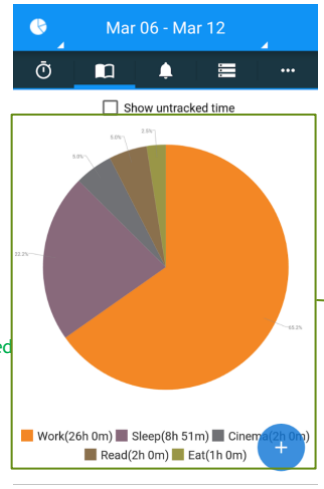
Mobile app: Manually tracking activities

- User may record their activity, duration and time manually
- User may create **goals** and see how their progress from time to time
- E.g.: aTimeLogger


Goals
Daily work duration
8 h 0 m a day
07:50:00
00:10:00
Weekly sport
5 h 0 m a week
00:00:00
05:00:00
Daily sleep
8 h 0 m a day
08:51:00
00:51:00
Weekly read
5 h 0 m a week
02:18:59
02:41:00
Your goal
Time needed to reach the goal
Your actual time to reach the goal


Activities
Read
00:00:28
War and peace
Work
08:00:00
Sport
Sleep
Transport
Eat
Read
Work
Shop
Entertainm...
Housework
Cinema
Walk
Study
Internet
Recording your activities


Mar 06 - Mar 12
March 12, Saturday
Work
11:56 AM - 07:56 PM
08:00
Sleep
12:05 AM - 08:56 AM
08:51
March 11, Friday
Read
08:56 PM - 10:56 PM
02:00
Eat
07:56 PM - 08:56 PM
01:00
Work
10:56 AM - 07:56 PM
09:00
March 10, Thursday
Cinema
08:56 PM - 10:56 PM
Activities recorded in a day


Mar 06 - Mar 12
Show untracked time
Work(26h 0m)
Sleep(8h 51m)
Read(2h 0m)
Eat(1h 0m)
Proportion time spent in a week

INDIVIDUAL QUESTIONNAIRE:

1. Which type of automation would you prefer to log your life activity? Why?

   You may also relate the answer to the sensitivity and usefulness of information presented

2. What information that you not object to sharing with others (e.g. personal tutors, university, peers)?

3. How do you think points/digital badges can have a positive impact on user?

LIST OF MAIN QUESTIONS

Ok, so far, thank you for your answer in individual questionnaire. You still can have the questionnaire, just in case you want to add some opinion later on. I'll collect the form once the discussion is over.

So, now let's move to the next part that is a group discussion.

Let me continue with the guidelines of our discussion:

There are no right or wrong answers, only differing points of view and its normal.

We're tape recording, so one person speaking at a time and I hope your voices are clearly audible

We're on a first name basis.

You don't need to agree with others, but you must listen respectfully as others share their views

We ask that your silent mode mobile phones. If you cannot and if you must respond to a call, please do so as quietly as possible and re-join us as quickly as you can.

My role as moderator will be to guide the discussion, so please talk to each other participant.

So the first topic is about **Location tracking**. We've seen three kinds of automation in location tracking.

1. Automatic location tracking all the time (Hypertrack-automatically record your location, less hassle since no need for user confirmation)

2. Semi-automatic location tracking: Apps detect the user's location which will not be recorded until the user confirms that they want to check in to the location.

3. No Automation:

    a. User clicks on the location on a map, then it is recorded by the system

    b. User types the location's name

Which automation do you like better? Why

OK, thank you for sharing your views and fruitful discussion. And now let's continue to the next topic: **Data sharing with others**

Apart from the information about date, time and location during your study and work, is there any information would you like to record in your journal?

What information would you not object to share with your personal tutor, university, peer (e.g. daily/weekly/monthly stats)?

Which sharing mechanism do you prefer, share anonymously or with identifiable information?

- Share anonymously so others may get insight into the students cohort's behaviour, e.g.: the average time spent for work/study daily/weekly/monthly

- Share as identifiable information so students may refer to the tutor to get personalised feedback?

Well done. Now we continue to the topic: **Gamification**

Let say there's some badges that you can earn from this app, e.g.:

- super easy to get e.g.: night owl, early bird or

- based on performance: Well done, Great, Brilliant

How do you think points/digital badges can have a positive impact? Will it make the journal logging more motivating, engaging and fun? Would you share your badges to others (personal tutors, university, peers)?

Well done. Now we continue to the last topic: **Other features**

What features that you would like to have ? why?

Which features that you think most important? why?

Appendix C. Usability testing plan

Steps	Time	Materials
Step 1: Welcome The moderator welcoming participants - Welcome - Participants consent	5 mins	Welcoming Script Participant consent form
Step 2: Opening questions Moderator send the designs' link for each task via zoom chat. Participants observe the design, and thinking aloud while completing the task.	30-60 mins	Task list
Step 3: Prioritising mobile app feature Ask the participants to prioritise the mobile app feature based on their preference.	5 mins	
Step 4: Closing Say thanks and give the giftcard	5 mins	

WELCOMING SCRIPT

Welcome to this Usability Testing.

Introduce moderator

Our topic is designing personal learning analytics app for students. This app is aimed to help students to keep their study/work record so students may see their behaviour/pattern.

The results will be analysed and used as design consideration in building the mobile apps for students.

You were selected because you are students at Newcastle University and willing to join this group discussion.

PARTICIPANT CONSENT FORM

Project Title: Personal Learning Analytics Application for Students

---

Researcher: Andharini D Cahyani

School of Computing, Newcastle University

a.d.cahyani2@newcastle.ac.uk

	Please Tick
5. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.	☐
6. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.	☐
7. I understand and agree to take part in the above study.	☐
8. I agree to the use of anonymised quotes in publications	☐

Name of Participant	Date	Signature
_____	_____	_____

TASK LIST

Task Instructions	Probe Questions
Task1: User Registration Imagine that you downloaded this study tracking application for the first time and you wish to login via the following set of images. Have a look at the screen carefully to register first and login.	Where would you start to look for this information? What keyword or title are you specifically looking for? How did you find this task? Was this an easy/difficult task? Why do you say this?
Task 2: Managing goal You have already have goal to have group discussion with your peers at least 2h/week. You want to view your progression in completing this goal. Could you please edit your goal to be *inactive* as you no longer want this goal in the future?	Where would you start to look for this information? Upon selecting this page, what do you think of the layout and information on the page? Is there anything unclear? Have a read of the information. Do you think the instructions is clear and easy to follow? How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?
Task 3: Enter new schedule You have an agenda at 14 April 2020 to have a discussion with your groups regarding CSC 1034 assignment. Could you please record this agenda and set reminder 10 mins and 30 mins before the due.	Where would you start to look for this information? Upon selecting this page, what do you think of the layout and information on the page? How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?
Task 4: Manage location tracking mode. As you are already registered, you want to use the application. But the first thing you should do is to set the location tracking mode before you use it to record your activity.	What do you think about the page layout? Why do you say that? Upon selecting this page, what do you think of the layout and information on the page? Have a read of the information. Do you think the instructions is clear and easy to follow?

Could you please set the tracking mode to: semi-automatic location tracking?	How did you find this task? Was this an easy/difficult task? Why do you say this?
Task 5: Enter an activity record in automatic location tracking mode As you selected *Automatic Location Tracking* mode, now your location is automatically tracked, so you don't need to input / edit location everytime you want to record your activities. Could you please record an activity (with the duration) on 25 January 2020?	What keyword or title are you specifically looking for? Is this what you would expect? Why do you say this? What do you think of the layout of this page? Are there any other features would you expect or like to find? How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?
Task 6: Enter an activity record in no location tracking mode As you selected *No Location Tracking* mode, now your location is not tracked at all. Could you please input location and details of activity (with its duration) on 25 January 2020?	Where would you start to look for this information? Is there anything unclear or unexpected? How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?
Task 7: Enter activity tracking in semi automatic location tracking As you selected *Semi Automatic Location Tracking* mode, now your location is tracked, but you need to confirm the location detection first before inputting activity details. Could you please record and activity and its duration on 25 January 2020?	Where would you start to look for this information? Is there anything unclear or unexpected? How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?
Task 8: View user and cohort weekly stats You have used the apps to record your activity for a week. Now you want to see your weekly stats and your cohorts' stats.	Where would you start to look for this information? Upon selecting this page, what do you think of the layout and information on the page? Is there anything unclear?

Could you please compare your stats with your cohorts'?	How did you find this task? Was this an easy/difficult task? Why do you say this? Can you suggest any improvements?

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