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Reducing Desk-Based Sedentary Behaviour in University Settings using Personalised Digital Health Solutions: An Application of the Integrate, Design, Assess and Share (IDEAS) Framework for UX Design.

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This dissertation was submitted in part fulfilment of requirements for the degree of MSc Digital Health Systems

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DECLARATION

This dissertation is submitted in part fulfilment of the requirements for the degree of MSc of the University of Strathclyde.

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ABSTRACT

Purpose: Desk-based sedentary behaviour in university settings is an important concern. Due to the unique mix of university populations, they remain a significant target for sedentary behaviour (SB) interventions (Montagni *et al.* (2018), particularly in terms of health app use. The research was concerned with reducing desk-based sedentary behaviour in university settings using a personalised digital health solution

Design, Methodology and Approach: The IDEAS framework (Mummah *et al.* 2016) was used to explore how a personalised digital health solution might help manage desk-based sedentary behaviour. The framework was selected because it integrates behavioural theory, design thinking, user-centred design, evaluation and dissemination approaches, which are suitable to address the research aims and objectives. A Total of 10 participants were involved in this study, which took place in three phases; (1) semi-structured interviews, (2) low-fidelity prototype evaluations and high-fidelity prototype evaluations.

Findings: The research indicated that a personalised digital health solution would be an acceptable means of managing desk-based – SB. It is recommended that researchers build a fully functional version of the prototype app and rigorously test it with more users.

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Chapter 1: Introduction

1.0 Chapter Introduction

This chapter briefly sets out the background in which the dissertation is positioned – digital health applications. It then presents an overview of sedentary behaviour (SB), including the key issues with its current evidence base. Next, it explores how digital health applications might address SB, particularly in the context of personalised notifications. Following this, university settings are presented as a unique space in which digital health solutions including anti-SB apps could be explored. The dissertation's overall aim, research objectives and research methods are outlined and justified. To conclude, the added value of this research is stated.

1.1 Background

Digital Health Applications

Digital technologies for health (digital health) is an established field of practice for the use of innovative information and technology (ICT) for health needs. The World Health Organization (2019a) defines digital health as "a broad umbrella term encompassing eHealth (which includes mHealth), as well as emerging areas, such as the use of advanced computing sciences in 'big data', genomics and artificial intelligence" p11. Here, *electronic health* (eHealth) is the "cost-effective and secure use of information and communication technologies (ICTs) for health and health-related fields" and *mobile health* (mHealth) is "a component of eHealth, and involves the provision of health services and information via mobile technologies, such as mobile phones, tablet computers and Personal Digital Assistants (PDAs)" (WHO, 2019b).

Since the introduction of smartphones in 2008, millions of health and medical applications (apps) have been developed and released onto the market for phones, tablet computers and wearable devices (Lupton, 2019). Major app stores namely, Google Play and Apple App Store host a variety of these health apps, ranging from self-tracking and fitness apps to managing pregnancies, diet, smoking cessation, mental health and well-being. This development has attracted researcher interest, particularly with technical designs, user-experience studies, their effectiveness in addressing behaviour change and the accuracy of their content (Lupton, 2016; Lupton 2019).

The emerging scholarship on the effectiveness, acceptability and user perceptions of digital health apps draws form several disciplines including medicine, public health, design and technology, sociology, politics among many. However, standards and clear guidelines for the development of health and medical apps i.e. planning, requirements gathering, analysis and evaluations/application testing are still lacking (Van Velthoven *et al.* 2018). There is a systematic protocol underway to

review these standards as a "critical 'stepping stone' to producing actionable guidelines for developers and adopters" (Van Velthoven *et al.* 2018, p. 1.).

Beyond their design, there are other issues with health apps that require attention. In exploring the "dark side" of digital health, Maturo *et al.* (2018) critically analyse the consequences of surveillance in post-modern societies. They draw our attention to the relentless activity of data collection about our bodies, behaviours and lifestyle. Ross (2018) and Lupton (2018) use Michel Foucault's theories (biopolitics, biopower and surveillance of the human body) to argue that health tracking and fitness devices should be approached with caution. Ross (2018) underscores the importance of recognising and understanding "both the positive and the negative outcomes associated with forcing specific information upon people or recommending that they track it" p141.

Undeniably, the notion of 'tracking' personal behaviour involves the collection and analysis of personal data and is a central activity with most health apps. This highlights the fundamental issue of trust, data security and privacy with health apps. The General Data Protection Regulation (GDPR) (ICO, 2018) offers a new framework in which designers and developers of health and medical apps must adhere to in order to protect users' data, however it is not always clear how developers apply it. The European Commission's *Privacy Code of Conduct on mobile health apps* (currently being redrafted in light of the GDPR) is a voluntary code that may offer additional guidance on how to apply the principles of data protection, for example through privacy by design and by default (European Commission, 2016).

The interdisciplinary nature of digital health poses some challenges in terms of values, assumptions, methodology and culture (Blandford *et al.* 2017). This is evident in the tension between digital health's main areas of expertise – health and human-computer interaction. Indeed, previous researchers began presenting new ways of overcoming these distinctions by producing novel research strategies that complement rather than divide these differences (Mummah *et al.* 2016). Taken together, these issues are critical aspects for the design and development of effective digital health apps and present some implications for anti-sedentary apps.

What is Sedentary Behaviour?

The word *sedentary* has its roots in the Latin word '*sedere*', which means "to sit" (Owen *et al.* 2010). Sedentary Behaviour (SB) is defined as any waking behaviour characterized by an energy expenditure \leq 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture (Sedentary Behaviour Research Network, 2012). Thus posture (sitting, reclining or lying) coupled with the level of energy expenditure are the defining components of SB. SB is framed as a public health concern that is distinct from physical activity (PA), yet despite the scholarship linking SB to adverse health effects, the evidence-based remains questionable. A recent study critically evaluated the key evidence related to the guidance on sitting for adults found that little is known about the independent detrimental effects of sitting (the ubiquitous behaviour of central concern with SB), there are unresolved issues with SB's exact definition and inconsistencies with epidemiological studies (Stamatakis *et al.* 2018). Of particular contention is the absence of consistent evidence-based advice for 'sedentary breaks' i.e. regular interruptions of prolonged sitting (Spence *et al.* 2017; Stamatakis *et al.* 2018).

The current argument for sedentary breaks rests on its link to adverse cardiometabolic health, however few large-scale prospective studies support this finding (Stamatakis *et al.* 2018). The call for public health guidelines, specifically for sitting has been an ongoing endeavour for public health researchers for years (Healy *et al.* 2008; Schmid *et al.* 2017; Chaput *et al.* 2018). There is still a need for clarification regarding SB's relationship to PA (Spence *et al.* 2017). At best, many countries have produced national guidelines for SB in adults and children, often as an *added* segment to existing guidelines on PA (Schmid *et al.* 2017; Stamatakis *et al.* 2018).

Digital Health Applications as an Anti-Sedentary Behaviour (anti-SB) Intervention

To date SB interventions comprise of breaking up excessive SB with brief physical activity breaks including but not limited to television lock out systems, portable pedometers with motivational websites, goal settings sessions and expensive work-based equipment (Bond *et al.* 2014). However, with the advent of smartphone apps, new ways of managing SB have emerged. One benefit with using smartphones for SB interventions is their ability to automatically monitor SB time via in-built accelerometers, removing the demand for self-monitoring practices (Bond *et al.* 2014). Moreover, smartphone apps can utilise these data to provide personalised real-time, behavioural prompts to interrupt SB with physical activity breaks, and feedback to the user is often presented in engaging and entertaining formats including gaming elements that encourage motivation to adhere to the app's intervention protocol (Bond *et al.* 2014; King *et al.* 2016). Other important features for anti-SB apps include behaviour change techniques (BCTs) (Dunn *et al.* 2018), tailored feedback (Arrogi *et al.* 2017), goal setting (King *et al.* 2013), self-monitoring (Wyke *et al.* 2019) and personalised reminder messages (Yang *et al.* 2017) among others.

1.2 Overall Research Aims and Individual Research Objectives

While there is evidence that SB can cause adverse health outcomes the current scientific evidence base does not support recommendations *beyond* broad advice for *reducing sedentary time* and *for breaking up prolonged sitting frequently* (Schmid *et al.* 2017; Stamatakis *et al.* 2018). Developers adopt these broad recommendations to support the use of anti-SB apps, mainly in office-based employees, and usability studies remain limited to that target group.

Recent studies have provided mixed reviews on the efficacy of anti-SB apps (Yang *et al.* 2017; Arrogi *et al.* 2017 and Wyke *et al.* 2019) and there is still a need to explore how they work in more diverse settings (Prince *et al.* 2014). Due to the unique mix of university populations, they remain an important target for SB interventions (Montagni *et al.* (2018), particularly in terms of health app use and their acceptability with attention to reasons of adoption/non-adoption and continuance/non-continuance of use.

The dissertation is concerned with advancing our understanding on the requirements for an anti-SB app in a local university. The main research question asks, 'how might a personalised digital health solution help manage desk-based sedentary behaviour in university settings?'. The main objectives are;

- Objective one: Review the literature on the effectiveness and usefulness of existing antisedentary smartphone applications (apps) and their key features (Literature Review, Chapter 2)
- Objective two: Explore student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications, including barriers and facilitators to its use (Semistructured interviews, Chapter 4)
- Objective three: Design and evaluate a high-fidelity prototype (anti-sedentary app) for a university setting. (Design and evaluation process, Chapter 6)

1.3 Outline of Research Methods

This dissertation is guided by a framework specifically created for digital health interventions. The Integrate, Design, Assess, and Share (IDEAS) framework (Mummah *et al.* 2016) draws on behavioural theory, design thinking, user-centred design, evaluation and dissemination. Its multi-disciplinary basis and focus on creativity is its strength as a research strategy. The application of IDEAS to the

research aims and objectives of the present dissertation will ensure that the digital health solution has addressed behavioural theory, obtained qualitative insights from the target population and designed/evaluated useful prototypes.

1.4 Value of the Research

The University of Strathclyde engages in promoting health activities campus wide. Its *Physical Activity for Health* research aims to embed the latest technologies including mobile and web-based technologies to encourage people to do more physical activities and engage in less sedentary behaviour across the lifespan.

This research is the first to explore the concept of an anti-sedentary app for the University of Strathclyde's student/staff population. By obtaining user insights on this topic, it is anticipated a meaningful analysis will emerge and advance our understanding for anti-SB interventions in universities. While not generalisable beyond its present context, the findings may be of interest to anti-SB developers, and may contribute the university's health promotion endeavours, particularly aimed at SB.

1.5 Dissertation Outline Structure

Chapter 1: Introduction

This chapter briefly sets out the background in which the dissertation is positioned – digital health applications. It then presents an overview of sedentary behaviour (SB), including the key issues with its current evidence base. Next, it explores how digital health applications might address SB. Following this, university settings are presented as a unique space in which digital health solutions including anti-SB apps could be explored. The dissertation's overall aim, research objectives and research methods are outlined and justified. To conclude, the added value of this research is stated.

Chapter 2:

This chapter presents a rationalised and prioritised set of requirements for a digital health solution to help staff and students manage desk-based sedentary behaviour at the University of Strathclyde. Data gathering, such as feedback on potential solutions from target users is a central activity in the IDEAS framework and occurs iteratively in all ten steps (Mummah *et al.* 2016). The chapter's aims are twofold; first, to understand the target users' activities and the context of that activity so that the digital health solution can assist them with reducing SB. Second, to establish stable requirements that support the design process.

Chapter 3:

The findings from the literature review indicated that studies on anti-SB apps were limited to officebased employees. There was a call for more diverse studies to be performed in different settings and other target groups. The present research responds to that gap by exploring student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications (objective 2), and the designing and evaluation of a high-fidelity prototype (objective 3). This chapter will provide the details of the research strategy adopted to carry out the objectives mentioned above. The application of IDEAS to the research aims and objectives ensured that the digital health solution addressed behavioural theory, obtained qualitative insights from the target population and produced, designed/evaluated useful prototypes.

Chapter 4:

This chapter is concerned with research <u>objective two</u>: Explore student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications, and asks "What user insights can be elicited from this user group?", "Which app features do they perceive as useful for an anti-SB app in Strathclyde university's context?" and "Are there any barriers or facilitators they perceive with an anti-SB app?" Understanding these questions may allow for the design of a more effective digital anti-SB solution.

Chapter 5:

This chapter presents a rationalised and prioritised set of requirements for a digital health solution to help staff and students manage desk-based sedentary behaviour at the University of Strathclyde. Data gathering, such as feedback on potential solutions from target users is a central activity in the IDEAS framework and occurs iteratively in all ten steps (Mummah et al. 2016). The chapter's aims are twofold; first, to understand the target users' activities and the context of that activity so that the digital health solution can assist them with reducing SB. Second, to establish stable requirements that support the design process.

Chapter 6:

In the IDEAS framework, the ideation, prototyping and gathering user feedback (evaluation) is a rapid, iterative phase. This chapter follows the process of ideating, low fidelity prototyping (with user feedback evaluations) and high-fidelity prototyping (with user feedback evaluations). In doing so, it aims to fulfil objective three: Design and Evaluate a high-fidelity prototype (anti-Sedentary Behaviour app) for a university setting. The chapter draws on findings from the literature review (Chapter 2), target user interviews (Chapter 4) and requirements gathering chapter (Chapter 5).

Chapter 7:

This chapter revisits the research aim and objectives, discusses the overall conclusions and makes some recommendations.

Chapter 2: Literature Review

2.0 Introduction

This chapter is directed at research objective two; Review the literature on the effectiveness and usefulness of existing anti-sedentary smartphone applications (apps) and their key features. It begins by defining sedentary behaviour as an important public health issue. It situates SB in the context of the United Kingdom, describing the economic burden it has on the National Health Service (NHS). Next it critically explores the evidence for sedentary breaks, and the related literature on the effectiveness of existing anti-SB apps. The chapter closes by exploring important design features in anti-SB apps.

2.1 Sedentary Lifestyle as an Emerging Health Risk and Public Health Issue

Modern technology has permitted a sedentary lifestyle change in adults in the United Kingdom (UK). Sedentary Behaviour is distinct from physical activity and is defined as any waking behaviour characterized by an energy expenditure \leq 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture (Sedentary Behaviour Research Network, 2012). The UK's Department of Health's guidelines recommend adults to reduce total sedentary time by breaking up extended periods of sitting (DoH, 2011). A recent Scottish Health Survey reported that adult leisure sedentary behaviour varied by age, with adults aged 25 – 54 spending between 4.2 to 4.5 (mean hrs) on weekdays and 5.3 to 5.6 (mean hours) on weekends. Older people (65 years and above) were more sedentary on weekdays (6.5 to 7.1 hours) and weekends (6.6. to 7.3 hours) (Scottish Government, 2018).

Sedentary behaviour has been linked to adverse health outcomes including cancers (Gierach *et al.* 2009; Simons *et al.* 2013; Ukawa *et al.* 2013; all-cause mortality (van der Ploeg *et al.* 2012), CVD incidence (Bjork Petersen *et al.* 2014) and Type 2 diabetes (Stamatakis *et al.* 2017). An estimate of direct healthcare costs related to prolonged SB (sedentary \geq 6 hours/day) was recently released. According to Heron *et al.* (2019), SB costs the UK the National Health Service (NHS) £0.7 billion in 2016-2017 (after adjustment for co-morbidities). The authors further report that 69 276 SB-related UK deaths might have been avoided in 2016 if SB been reduced in the UK. They call for the prioritisation of SB in public health programmes. Despite this, the issue of SB on the national public health agenda is still not a priority. Researchers and developers continue to design products based on users taking regular sedentary breaks, however the evidence to support this has been controversial.

2.2 Current evidence for 'Sedentary Breaks'

Many sedentary behaviour interventions on smartphone apps use the concept of 'sedentary breaks' or 'sitting interruptions' as the central task for users to perform. It is in performing this central task that users will gain the benefit of regularly breaking up prolonged SB, that is improved cardiometabolic health. It becomes an issue of contention when the evidence base for that central task is challenged. Yet despite this, others argue that in the absence of more rigorous evidence-based SB research, the best available evidence can still provide much needed public health guidance (Chaput *et al.* 2018).

The concept of sedentary breaks was first introduced by Healey *et al.* (2008). They performed a cross sectional study on 168 adults, measuring interruptions of sedentary time on an accelerometer and examined the association of breaks in objectively measured sedentary time with biological markers of metabolic risk. They found evidence that breaking up prolonged sitting can improve cardiovascular (heart and blood vessels) and metabolic (blood pressure, blood sugar, and triglycerides) health, consequently calling for "new public health recommendations regarding breaking up sedentary time that are complementary to those for physical activity" (Healey *et al.* 2008, p661).

However, evidence supporting this claim has been critiqued as 'inconsistent' and 'limited to smallscale trials' (Stamatakis *et al.* 2019). In their recent narrative review, Stamatakis *et al.* (2019) argue that the evidence in support of 'sedentary breaks' is frail. To justify their critique, they cite a crosssectional study by van der Berg *et al.* (2016) which was performed on 2,497 participants, as having no associations between sitting and glucose metabolism. And note that Healey *et al.* (2011) found that breaks were only associated with waist circumference and C-reactive protein and not with examined cardiometabolic risk factors. Diaz *et al.* (2017) conducted a prospective cohort study on 7985 participants using hip-mounted accelerometers to measure SB. Their analysis reveals that sedentary time, as well as its accrual in prolonged, uninterrupted bouts were both significantly associated with all-cause mortality over four years. It is important to note that the breaks were accompanied with some ambulatory movement, and this may have produced the added benefit of physical activity to the measurement outcomes, as opposed to standing or light ambulatory movements as theory for sedentary breaks assumes (Stamatakis *et al.* 2019).

A scientific report from the *Physical Activity Guidelines Advisory Committee* (2018) acknowledged the links between SB and adverse outcomes (greater all-cause mortality, Cardiovascular disease

mortality and incidence, type 2 diabetes incidence, and the incidence of colon, endometrial, and lung cancer) but stressed that there was 'insufficient evidence' to confirm if breaks in SB reduce the risk. The committee still advice "For inactive adults, replacing sedentary behaviour with lightintensity physical activities is likely to produce some health benefits. Among all adults, replacing sedentary behavior with higher intensity (moderate-to-vigorous) physical activities may produce even greater benefits" (Physical Activity Guidelines Advisory Committee, 2018 p. 12).

Current UK guidelines for SB in adults states that "based on the current evidence, reducing total sedentary time and breaking up extended periods of sitting is strongly recommended" (DoH, 2011, p34). The implication being, sedentary breaks are an example of how to minimise SB i.e. "breaking up time spent sitting with regular short periods of standing or walking" (DoH, 2011, p.43). There remains a call for UK policy-makers to prioritise SB as a major public health issue (Heron *et al.* 2019).

2.3 Related Evidence on the Effectiveness of Anti-SB Apps

The question of what type of research is best placed for evaluating the *effectiveness* of a digital health intervention is ongoing (Mummah *et al.* 2016; Blandford *et al.* 2018). Randomised controlled trials (RCTs) are described as the optimal study design to minimise bias and accurately estimate an intervention's clinical effectiveness (MRC, 2000). Yet the number of years required to complete an RCT often means that the intervention under study becomes obsolete due to rapidly evolving technological advances.

In the context of anti-SB apps, there are hundreds that aim to reduce SB via prompting breaks in prolonged bouts of inactivity (van Dantzig et al. 2013). There still remains the need to establish clinical effectiveness and build a stronger evidence base. The effectiveness of anti-SB apps is not without criticism. For example, several anti-SB RCTs have been performed in recent years (Hebden *et al.* 2014; Arrogi *et al.* 2017; Yang *et al.* 2017; Wyke et al. 2019) but have yielded inconsistent results, with most of them reporting minimal or no significant change with SB. The research from Hebden *et al.* (2014) and Arrogi *et al.* (2017) were performed on a small number of participants and not generalisable beyond their respective contexts. While these studies show that anti-SB app interventions can be successful, their reduction in sedentary behaviour was slight. Moreover, due the lack of standardisation, it is difficult to draw meaningful comparisons between them, e.g. both use different behaviour change theories.

More recently, Wyke *et al.* (2019) conducted an RCT (n = 1,113 men) in 15 football clubs in four countries (Netherlands, Norway, Portugal, England). Their group-based interventions (EuroFIT, SitFIT and MatchFIT) drew on several behaviour change techniques and objectively measured sedentary time and physical activity over a 12-month period. While improvements in diet, body weight, indicators of cardiometabolic health, well-being were shown, there were no significant reductions in sedentary time at 12 months. The further indicates that reducing SB remains a challenge. They recommend that future lifestyle interventions note the distinction between physical activity and sedentary behaviour. The study was directed at engaging underserved men, as such the findings should be understood in that context.

2.4 Universities as an Important Setting for addressing 'Desk-Based Sedentary Behaviour'.

The modern university is not just a site for information and professional educational training, it is a unique setting for cultivating health promotion for individual health and at the university population level. Universities are beginning to use digital health solutions to improve the health and well-being of students and staff (Keenan *et al.* 2014; Wang *et al.* 2016; Montagni *et al.* 2018). For example, smartphone-based health apps have been used to promote healthy eating (Wang *et al.* 2016), reduce drug use (Kazemi *et al.* 2017), address alcohol abuse (Gajecki *et al.* 2014; Gajecki *et al.* 2017) and enhance mental health (Lee and Jung, 2018).

Desks are an important site of study in SB research. It here were most SB-related sitting takes place daily. Ryde *et al.* (2014) argue for more detailed studies on sitting time at desks in order to understand and change occupational sitting habits. Their study measured desk-based SB in full time university employees. They found the employees spent around 8 hours per day at work and 67% of that was spent sitting at their desks. While they had frequent breaks, these often occurred after around 20 minutes of consecutive sitting. The university population are an important target group that might be especially susceptible to SB due to the nature of their job obligations (staff i.e. planning lectures, research, grading) and study obligations (students i.e. lectures, exam periods, assignment demands) all of which are often performed at a desk, on a computer/laptop for long periods of time.

2.6 Important Design Features in Existing Anti-SB Apps: Personalisation and Notifications in Digital Health Applications

Smartphones are becoming an important part of everyday life; they are often always on, and always with the user. In the context of digital health apps, smartphones can enhance the accuracy, richness and reliability of data available to the user. Other features include sensors, GPS, accelerometers and gyroscopes all of which can accurately measure the amount, type and duration of physical activity performed by the user (Freyne *et al.* 2017). Their ubiquity positions them for prime interventions, where "health content is delivered, the triggers for user interactions are sent, the necessary data is gathered, and user feedback is obtained" (Freyne *et al.* 2017, p.). Through gentle prompts, the user is reminded *several* times a day to engage with the behaviour change intervention on the app. Therefore, the type of tasks demanded by the apps as well as the frequency, style and timing of notifications become essential to the continued engagement of users and health apps (Turner *et al.* 2015). This may have implications for the design of personalised notifications for anti-SB apps.

There is interest in the concept of 'smart' or intelligent notifications, where smartphones learn user preferences for being notified in different situations. The personalised notification would adapt to the types of interruptions that the user prefers and the context in which the user is in (Lopez-Tovar *et al.* 2015) thus focusing on an individual's personal preferences instead of the 'one size fits all' paradigm (Zhang *et al.* 2005).

Personalised features of digital health apps such as notifications improve user experience (Milward *et al.* 2017; Visuri *et al.* 2019). Notifications may be a core feature of smartphone devices, but they have caused stress and disruption (Westermann *et al.* 2015; Gallud and Tesoriero, 2015; Exler *et al.* 2016; Westermann, 2017) and sometimes leading to users uninstalling an app.

Moreover, smartphone apps can utilise these data to provide personalised real-time, behavioural prompts to interrupt SB with physical activity breaks, and feedback to the user is often presented in engaging and entertaining formats including gaming elements that encourage motivation to adhere to the app's intervention protocol (Bond et al. 2014; King et al. 2016). Against this backdrop, many researchers argue that more findings from qualitative, user-centred research are equally valid (King et al. 2013; King et al. 2016).

Other important features for anti-SB apps include behaviour change techniques (BCTs) (Dunn et al. 2018), tailored feedback (Arrogi et al. 2017), goal setting (King et al. 2013), self-monitoring (Wyke et al. 2019) and personalised reminder messages (Yang et al. 2017) among others.

Lastly, behaviour change techniques (BCTs) are an important feature in anti-SB studies. In their systematic review on BCTs for anti-SB apps (50 apps from Google Play and iTunes), Dunn et al. (2018) found that the majority of apps have fewer BCTs in them. Yet they have been cited as crucial for behaviour change apps. The authors concluded that future SB apps would be more effective with the incorporation of more appropriate BCTs.

2.7 Conclusions

The evidence base for the effectiveness of anti-SB apps is still growing. There are many studies that aim to evaluate the effectiveness of anti-SB. Often they are RCTs, performed on small sample sizes, showing little or no change in SB, and using a variety of techniques and theories. There are key methodological limitations that make it difficult to draw a comparison between these interventions.

The recommendation of breaking up prolonged SB of with 'sedentary breaks' is based on the best available evidence, and is supported by the UK's Department of Health.

Chapter 3: Research Methods

The findings from the literature review indicated that studies on anti-SB apps were limited to officebased employees. There was a call for more diverse studies to be performed in different settings and other target groups. The present research responds to that gap by exploring student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications (objective 2), and the designing and evaluation of a high-fidelity prototype (objective 3). This chapter will provide the details of the research strategy adopted to carry out the objectives mentioned above. The application of IDEAS to the research aims and objectives ensured that the digital health solution addressed behavioural theory, obtained qualitative insights from the target population and produced, designed/evaluated useful prototypes.

3.1 Research Strategy

Choosing this research strategy began with some reflection on the research aims, objectives and the literature review. To explore the staff/student views on anti-SB apps required a qualitative method that would generate rich, detailed data. To ensure the target users' needs are captured in relation to a digital health solution, a user centred approach would be required. To design and evaluate an effective digital health solution would require an element of design thinking and evaluation techniques. Collectively, these research disciplines would allow the author to draw some meaningful UX (user experience) insight into the target population and target behaviour. The Integrate, Design, Assess, and Share (IDEAS) Framework (Mummah *et al.* 2016) provided an appropriate toolbox in which to explore the present dissertation aims and objectives. The framework essentially pulls on four existing research frameworks in their own right and produces a step-by-step process for integrating them (behavioural theory, design thinking, user-centred design, rigorous evaluation, and dissemination approaches) to guide the development and evaluation of more effective digital Interventions (see figure 1).



Figure 1. IDEAS (Integrate, Design, Assess, and Share) framework for developing digital health behavior change interventions.

Although portrayed in a linear fashion, the authors recommend using the framework iteratively, visiting each stage as necessary. It was beyond the scope of this research to complete all ten steps,

as this would have included coding a fully functioning app (Step 7) and performing an RCT (Step 9). Below is a description and justification of why phases 1 to 6 were selected;

3.1.1 Phase one concerns empathising with target users by gathering qualitative insights via interviews and focus groups. Understanding user needs and motivations is an essential prerequisite for effective behaviour-change interventions and the findings of this phase guided the planning and designing of the potential anti-SB app.

3.1.2 Phase two utilises the insights gathered from target users to define a target behaviour. In addition, it translates broad behavioural goals into highly specific target behaviour that is aligned with research findings. The target behaviour defines the purpose of the intervention and becomes the outcome to measure its success. For example, the UK Department of Health's goal of 'reducing sedentary behaviour in adults', can be refined to 'take short, regular sedentary breaks every 30 minutes.'

3.1.3 Phase three grounds the intervention in behavioural theory by identifying behavioral strategies best suited to the target users. Following the user target interviews, behaviour change techniques were aligned to the user findings, e.g. personalisation and setting goals.

3.1.4 Phase Four Ideates implementation strategies by brainstorming creative strategies for translating theory and insights into app features. This step involves the creation of several alternative ideas.

3.1.5 Phase Five creates prototypes of potential products. This phase included sketches, paper prototypes and clickable mock-ups of several interface designs.

3.1.6 Phase Six gathers user feedback through interviews and questionnaires. The author decided on a usability inspection method, as the task was for users to evaluate the interfaces and highlight any usability related concerns (Nielsen, 1994; Nielsen Norman Group). There at least four methods in which users can evaluate user interfaces;

- 1. Automatically (usability measures computed by running a user interface specification through some program).
- 2. Empirically (usability assessed by testing the interface with real users)
- 3. Formally (using exact models and formulas to calculate usability measures)

4. Informally (based on rules of thumb and the general skill and experience of the evaluators).

Figure 2 represents these options. Based on the objectives of this research, which are user focused, the author decided on having the users evaluate a real prototype using question-asking protocols.



Figure 2. Usability Evaluation Technique Classification (from Yáñez-Gómez et al. 2017)

The evaluation technique used on the low-fidelity prototypes included the 'Wizard-of Oz (WOz)' and the 'think-aloud'. In the Woz, the user interacts with the 'software' as though it was the real product. Participants were encouraged to think-aloud, continuously verbalising their thoughts as go through the user interfaces. The session was video-taped on an iPhone, only concentrating on the desk activities, hand movements and spoken words. The author took on the role of the 'wizard' and simulate and create changes in real-time from screen to screen, in response to an input from the participant.

Phases **seven** (Build a minimum viable product - MVP), **eight** (Pilot test to assess potential efficacy and usability) **nine** (Evaluate efficacy in a randomized controlled trial - RCT) and **ten** (share) require the building of a complete. As such they were not addressed in this research.

3.2 Justification of the Research Strategy

An IDEAS approach would enable the main research question for this dissertation "How might a personalised digital health solution help manage desk-based sedentary behaviour in university

settings?" to be achieved by allowing an in-depth, richer, iterative analysis between the researcher and the target user group. Given the nature of this research, where the perceptions of staff and students regarding an anti-SB solution is sought and a digital solution is designed and evaluated, this strategy is appropriate for the dissertation aim and objectives. Thus the IDEAS is based on important user experience (UX) principles such as 'Empathy mapping' (Gibbons, 2012), 'Usability' (Nielsen, 2012) and 'Design thinking' (Gibbons, 2016). Finally the IDEAS has an emphasis grounding any target behaviour in Behavioural Change Techniques (BCTs), which is a central part of anti-SB app design and intervention (Schoeppe *et al.* 2017; Dunn *et al.* 2018).

3.3 Recruiting Participants

Participants were recruited via a convenience sample. It is convenient because the author attends this university, and the participants have not been chosen by random. In this sense the author was not seeking a representative view of the whole university. The interest was in obtaining in-depth qualitative insight into staff/student perceptions of how an anti-SB might be useful for them.

Overall, 10 participants were recruited following the circulation of the study advertisement (see appendix [...]) to academic/student links via Twitter and Facebook. The advert was also shared in group emails at the student union. Ethical approval was granted by the University of Strathclyde, and all participants gave their consent to voluntarily take part.

3.4 Data Collection

Qualitative data collection took part in three phases. The aim here was to allow the participants' input at all stages of the research cycle; (Phase 1) semi-structured interviews (8 participants), (Phase 2) low-fidelity prototype evaluation (4 participants) and (Phase 3) high-fidelity prototype evaluation (8 participants). There was no obligation for the participants to commit to all three phases. The age range was diverse, between 18 – 64 years of age. The number of 'desk-based hours' per week ranged from 6hrs to 50hrs (26hrs on average across the 8 participants). All data were collected from the University of Strathclyde staff and students and is not intended to be an exhaustive account. The recorded semi-structured interviews (phase 1) were transcribed verbatim using a software auto-transcription tool called Trint (2019 software version). Trint uses automated speech-to-text algorithms to transcribe the uploaded texts. Trint does not have access to any files uploaded on their system in order to upkeep data privacy and security (Trint, 2019). An example can be found in appendix a.

3.5 Framework for Data Analysis

Thematic Analysis is a flexible and widely used interpretive 'method for identifying, analysing and reporting patterns (themes) within [qualitative] data' (Braun and Clarke, 2006, p.79). There are several analytic approaches in qualitative analysis, each broadly falling into four categories; framework analysis (e.g. Ritchie & Spence, 1996), thematic analysis (e.g. Braun & Clarke, 2006), Interpretative phenomenological analysis (e.g. Smith & Osborn, 2008) and constructivist grounded theory (e.g. Charmaz, 2000). The selection of an appropriate approach is grounded in theoretical assumptions and the nature of the research question. In the present dissertation,

Until recently, thematic analysis approaches had been criticised as lacking an established methodological approach to data analysis. However it is now increasingly recognised as an important research approach in its own right.

The data analysis framework will involve data description, followed by data interpretation – cross referencing the findings to the Literature Review findings will produce more meaningful analysis of the empirical data – illustrate data analysis results through diagrams/figures and tables – explain illustrations.

3.4 Ethical Considerations: Consent, Access and Participant Protection

Ethical clearance was sought from the University of Strathclyde's Ethics Committees to ensure the research is consistent with the principles of the General Data Protection Regulation (GDPR)/ Data Protection Act 2018 (ICO, 2018), that voluntary consent is made explicit and that scientific integrity is upheld. The necessary safeguards will be built into the information sheets and consent forms provided for all participants, where the main research aims will be made clear. The data will be kept on password protected computers and will be destroyed after 5 years. The research is not sponsored, nor is there any conflict of interest towards the research objectives or the treatment of the data obtained. Please see appendix a for the Information Sheet and Consent Form.

3.5 Validity and Reliability with the Research

Valid research refers to established research strategies and data collection techniques. The IDEAS framework is relatively new, however several researchers have 'tried and tested' it with a range of

digital health issues. For example, it has been used to guide a number of health interventions, ranging from RCTs on mental health self-monitoring approaches (Beiwinkel et al. 2017), to the development of guidelines for evaluating gamification apps for improving physical activities in adults living with autism. The flexibility of the IDEAS framework means that it can be tailored to suit the type of intervention under study. Fidele et al. (2019) for example applied the IDEAS as an organizing method to design, evaluate, and disseminate mHealth interventions for paediatric populations. Finally, Peleg et al. (2018) show how the conceptual phases (especially "ideating") was indispensable in ideating an app for health for compliance to therapy for patients with chronic disease.

Thus, the IDEAS research strategy is appropriate to the research question and objectives, uses data collection techniques that are relevant (e.g. semi-structured interviews, app reviews) and applies a suitable means of analysing the data (e.g. thematic analysis).

Reliable research is based on trust. For a full description of the participants involved across the dissertation please see Table . An example transcript and the topic guide can be found in appendix a. Details of the research site and who was involved in the research can be found chapter 4.

3.6 Limitations and Potential Problems

There are some limitations with this research. The findings from this research cannot be generalised to other universities nor can it be generalised to represent the University of Strathclyde as a whole. It is possible that another target group or a group of staff/students in a different part/sample of the university with different constraints may produce different findings. In terms of validity, the IDEAS has been applied in various digital health interventions, proving its appropriateness. The various components of the IDEAS framework have been tried and tested, consistent with the concept of reliability *rather* than generalisability.

Chapter 4: Integrate Insights from Users and Theory

4.0 Introduction

This chapter is concerned with research <u>objective two</u>: Explore student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications, and asks "What user insights can be elicited from this user group?", "Which app features do they perceive as useful for an anti-SB app in Strathclyde university's context?" and "Are there any barriers or facilitators they perceive with an anti-SB app?" Understanding these questions may allow for the design of a more effective digital anti-SB solution.

Regarding the IDEAS framework (the guiding strategy for this dissertation), this chapter responds to step 1 (emphasising with target users) and step 3 (grounding the research in behavioural theory). The overarching aim of this phase is to integrate target user feedback with the principles of behavioural theory, in order to inform the design of the digital health solution (Mummah *et al.* 2016) Consisting of three steps, this chapter describes how these steps were addressed:

Step 1: To *emphasize with target users*, semi-structured interviews were used to generate insights for the digital health solution for anti-SB, semi-structured interviews were carried out. The is step was to better understand the participants' desk-based SB, health app usage, challenges and opportunities to manage SB in the university environment.

Step 2: To *specify the target behaviour*, a literature review was performed (Chapter 2) and regular anti-SB breaks were established as having potential health benefits. Apps that target SB exclusively are more effective than those that include other goals such as increasing physical activity, or managing diabetes (Dunn *et al.* 2018).

Step 3: To *ground the digital health solution in behavioural theory*, the target user needs identified in the semi-structured interviews directly influenced the choice of target health behaviours that will underpin the digital health solution. The aim was to align the target user feedback with measurable, target behaviours that were acceptable to them, and could have a positive impact in their reduction of SB. The behaviour change techniques (Michie *et al.* 2011) as identified in chapter 2, have previously been used to target SB behaviours in anti-SB apps (Dunn *et al.* 2018).

4.1 Study Setting

The University of Strathclyde (Glasgow, UK) was founded in 1796 and has a rich history of teaching and innovation. Its city centre campus attracts up to 23,000 students from over 100 countries. As a

leading international technological university, it has won several Times Higher Education Awards (University of Strathclyde, 2019). Its motto is 'the place of useful learning'. The target population were staff and students, over the age of 18 currently working or studying at the University of Strathclyde (Glasgow).

4.2 Study Participants Recruited

Overall, 10 participants were recruited following the circulation of the study advertisement (see appendix [...]) to academic/student links via Twitter and Facebook. The advert was also shared in group emails at the student union. Ethical approval was granted by the University of Strathclyde, and all participants gave their consent to voluntarily take part. Data collection was carried out over three phases: (Phase 1) **semi-structured interviews** (8 participants), (Phase 2) **low-fidelity prototype evaluation** (4 participants) and (Phase 3) **high-fidelity prototype evaluation** (8 participants). There was no obligation for the participants to commit to all three phases. The age range was diverse, between 18 – 64 years of age. The number of 'desk-based hours' per week ranged from 6hrs to 50hrs (26hrs on average across the 8 participants).

Participant number	Gender	Ethnicity	Age bracket	Staff/Student	Average University- related desk-based work per week	Average hours of exercise per week	Health App Usage	Phase of research involvement Phase 1: Interviews Phase 2: Lo-fidelity Phase 3: Hi-fidelity
P1	Male	White	35-44	Student (MSc)	21hrs	7.5hrs	Pomodoro	Phase 1: Interviews (31:01 minutes/ seconds, 09/07/19) Phase 3: Hi-fidelity
Ρ2	Female	White	25-34	Staff (PhD)	32hrs	Walking, 7hrs	Habit Tracker Apple watch (several fitness apps) Nike Training Club	Phase 1: Interviews (28:58 minutes/ seconds, 09/07/19) Phase 2: Lo-fidelity Phase 3: Hi-fidelity
P3	Male	White	18-24	Student (PhD)	20hrs	2hrs	Pokémon Go	Phase 1: Interviews (40:21 minutes/ seconds, 10/07/19)

Table 1. Participant Demographics and Phase of Research Involvement

								Phase 2: Lo-fidelity Phase 3: Hi-fidelity
Ρ4	Male	Asian	35-44	Student (MSc)	14hrs	6hrs	Google Fit	Phase 1: Interviews (33:10 minutes/ seconds, 13/07/19) Phase 3: Hi-fidelity
Ρ5	Male	White	45-54	Student (MSc)	6hrs	Minimal/0hrs	Strava	Phase 1: Interviews (36:53 minutes/ seconds, 15/07/19) Phase 3: Hi-fidelity
Р6	Female	White	18-24	Student (MSc)	50hrs	6hrs	No	Phase 1: Interviews (26:55 minutes/ seconds, 16/07/19) Phase 3: Hi-fidelity
Ρ7	Male	White	25-34	Student (MSc)	12hrs at Uni, 8hrs at home (20hrs overall)	8hrs	Samsung fitness app	Phase 1: Interviews (32:07 minutes/ seconds, 16/07/19)
P8	Female	White	55-64	Student (MSc)	45hrs	Walking, 7hrs	Walking app Drink water app	Phase 1: Interviews (40:20 minutes/ seconds, 26/07/19)
Р9	Female	White	35-44	Student (PhD)	20hrs	-	-	Phase 2: Lo-fidelity Phase 3: Hi-fidelity
P10	Female	White	35-44	Staff (PhD)	-	-	Strava	Phase 2: Lo-fidelity Phase 3: Hi-fidelity

4.3 Conducting the Telephone Semi-structured Interviews

Each interview began with an introduction of the author (CW), an overview of the research aims and how their findings would be utilised. The order of the interview as per the topic guide was highlighted, so that the participants had an idea of the direction of the research. The author confirmed that the participant had read and understood the information sheet and consent form that was emailed to them prior the interview. Consent was then sought from the participants – three

had emailed a signed consent form, the rest were happy with providing verbal consent. All participants were reminded that they do not have to speak about anything they do not wish to, and they could end the interview at any time without a reason. Next they were reminded the interview would be digitally recorded, to allow an accurate analysis of their responses at a later stage. Finally, participants were given the opportunity to raise any concerns or clarifications before the interviews commenced. None of them raised any issues or clarifications.

The interview topic guide (appendix [...]) was developed after performing the literature review in Chapter 2 and split into three key themes; (1) the participants' desk-based sedentary behaviour, (2) the participants' smartphone/app notification behaviour and (3) the participants' perceptions of key anti-SB features. The questions were formulated into these distinct but connected themes to ensure each topic of concern was focused and not confusing to the participants. This was also to ensure the participants had time to reflect on each topic in a clear and unbiased manner. Each question allowed for follow-up prompts and probes depending on the participants' responses. An example of what the author asked or prompted included "why might that be?", "can you tell me a little more about that?", "How might that happen?" This was to explore the participants' unique trail of thought as the interview was ongoing.

All interviews began with the collection of basic demographics about the participant (age range, gender and ethnicity) in order to understand the diversity, characteristics and representation of the target group. This was followed by simple questions about their participation in exercise and the average number of hours they spent in desk-based university-related work per week.

All participant interviews were scheduled through the telephone as per the participants' preferences. The telephone semi-structured interviews were conducted individually, digitally recorded, conducted by a single interviewer (author, Carolina Wani – CW) and carried out between the 09/07/19 - 26/07/19. The interview time ranged from to 26:55 - 40:20 minutes/seconds. The first interview (participant 1) served as a pilot, to ensure the topic guide was sound. During the interviews, the author sought to focus the participants on the interview topic guide, whist allowing them to develop and clarify their responses.

4.4 Framework for Data Analysis: Thematic Analysis

The justification for use a thematic analysis as an analytic method for this dissertation was justified in Chapter 3: Research Methods. Here, the interest was to identify staff and student views/perceptions on anti-SB apps in the context of personalised notifications.

	Table 2.	Phases	of tl	hematic	analy	/sis
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Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and revising/naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Table 2. illustrates the six steps involved in the reflexive thematic analysis (TA) (Braun and Clarke, 2019). Themes were developed from coding and working with the data and codes, instead of preexisting codes. Thus, they are the outcome of the analytic process and not the start of the analytic process. Since the coding and development of themes are a subjective and interpretative processes, the outcomes are influenced by the researcher and can be 'weaker' or 'stronger' as opposed to right or wrong objectively. Thus, the researcher creates the analysis, and such an analysis sits at the nexus of the researcher's theoretical and conceptual frameworks, research skills and knowledge, disciplinary knowledge against the backdrop of the data.

4.5 The Data Analysis

1. Familiarisation of the data began with transcribing the recorded semi-structured interviews verbatim. This was completed by means of a software auto-transcription tool called Trint (2019 software version). Trint uses automated speech-to-text algorithms to transcribe the uploaded texts and it does not have access to any files uploaded on their system in order to upkeep data privacy and security (Trint, 2019). The transcriptions were reviewed i.e. listened to and proofread against the digital recording; the author made some minor corrections to words that the software did not articulate correctly, mainly due to variations in speaker accent and rate of speech. All real names were removed, and transcripts were labelled as per the interview number i.e. participant 1,

participant 2 etc. In addition, any terminologies or events that could identify a participant was removed.

To begin, all transcripts were analysed by hand. This rapid familiarisation involved using highlighters to underscore any potential codes and thoughts. Paper transcripts were cut up into broad areas of categorization - personalization, NHS links, games, notifications, interface designs, app themes, privacy and machine learning. Following this, it was decided a qualitative software would better assist with the organisation of the (many) generated codes. All 8 transcripts were imported into the Nvivo 12 software for formal coding.

2. Generating codes involved reading the transcripts and attaching clear labels (codes, nodes) to interesting segments of the data. In this sense, the analytic process was rooted in the data, working from the bottom up, i.e. an inductive orientation (as opposed to a deductive orientation, which is on the opposite end of the continuum where coding begins with pre-existing categories and theories). Each transcription was reviewed one by one before a cross case analysis searching for themes and patterns. As the author went through each transcript, codes were being generated and new codes were only introduced when the data did not fit into an existing code. The coding phase generated 173 codes (see appendix [...]).

3. Constructing themes from the generated codes began with reflecting on the present research aim and objectives. The themes remained flexible, and the author aimed collate codes and their associated data into coherent themes that might relay a story about a specific segment of data. This process required the identification of meaning-based patterns as opposed to the identification of a feature of the data, however some themes could only be identified by their feature. At this stage, ten master themes were generated; (1) Trust, (2) Personalisation, (3) Data, (4) Information, (5) Analytics, (6) Notifications, (7) Sedentary behaviour, (8) Movement, (9) Environment and (10) App.

4. In reviewing the themes, the author aimed to retain the richness of the data, without introducing weak or overlapping themes. The author arranged a meeting with her Dissertation Supervisor to clarify the process behind the theme generation. In addition, the author attended a 'coding clinic' with current MSc and doctoral students using the same research tools (06/08/19).

At the coding clinic, we selected one theme and discussed how the author arrived at that theme, including the codes generated and the excerpts to support it. We selected a theme called 'Trust' to review. Initially, we looked across the codes generated and assigned under 'Trust'. We reflected by

asking questions like "what does trust mean?" and responding with recognising that trust refers to "patterns of confidence, caring, intimacy, revealing private information, protection etc". There was a need to establish a central organising concept (an idea that captures and summarises the core point of a coherent and meaningful pattern in the data) for the theme.

The central organising concept of the new theme was 'confidence', i.e. confidence in the app, in the evidence the app uses, in trusting the safety of any personal data used by the app, in the evidencebased recommendations suggested by the app, in trusting the brand 'Strathclyde' for a solid app etc. Where the author had grouped "Data", "Information", "personalisation" and "Trust" as three separate themes, it was agreed to collapse them into sub-themes and have one master theme called "Confidence and trust as a means of engaging with the app". Using the ideas taken from the workshop, the author further refined the other themes.

5. To revise and define the themes, each theme was revisited to ensure the codes were organised around a central organising concept per theme. In addition, the themes were related back to the research question and specifically to Objective 2;

Explore student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications, and asks "What user insights can be elicited from this target group?", "What app features do they perceive as useful for an anti-SB app in University of Strathclyde's context?" and "Are there any barriers or facilitators they perceive with an anti-SB app?"

6. The sixth and final phase was producing the report. The findings were used to ground the data in behavioural theory and inform the design of the anti-SB app.

4.6 Placing the Findings in Existing Literature and Research



Figure 3. Visualisation of the Study Findings in a Word Cloud.

Figure 3. above is an overall visualisation of the most frequent words from the dataset (8 semistructured interviews). While word clouds emphasise the frequency of words and *not* their importance/meaning, they are still a powerful tool for communicating to an audience what the data is about.



Figure 4. Mind map of the generated themes from the semi-structured interviews

From the reflexive thematic analysis, one overarching theme (Personalisation) and six master themes (1. Accessibility, 2. Conceptualising sitting and movement, 3. Emotive language used on notifications, 4. Desired features for an SB app, 5. Confidence and trust in the SB app and 6. University of Strathclyde brand) were generated. Figure 4. presents a mind map of how the themes

conceptually relate to one another. All the participants had used health apps in their daily lives and were accepting of them. They understood sedentary behaviour and felt it was important to move often. The number of university-related 'desk-based hours' per week ranged from 6hrs to 50hrs (26hrs/week on average across the 8 participants). Each theme will now be compared to the existing literature in relation to the present dissertation aim and objectives. Where necessary, selected excerpts from the dataset (eight semi-structured interviews) will be used to illustrate the themes.

Theme 1: Personalisation as an Overarching Element

This theme seemed to be related directly or indirectly to all other thematic patterns identified in the data and seemed to be of importance to the participants. The implication was personalised notifications require privacy;

"Well let's say like I've got an appointment today and pops up being like 'oh remember to take some steps today' or 'remember to log if you've had any seizures'. Like I might not want other people to see that...the element of wanting to be personalised but not too personal that I wouldn't want other people to see it...But that's the only negative I could see for personal health." (P2) [00:17:37]

And trust in a system that can be tailored solely to the user;

"That's where the trust is established between the app and the user. The app should be able to convince the user that I am suggesting this to you. I am recommending this to you personally it is not generalised. The notification I am sending you, the recommendation I am sending you is absolutely customised as for your physical behaviour." (P4) [00:24:43]

Another important aspect of personalisation was the guarantee that "your data is not going to be used in any other kind of settings or they're not going to be sold to someone to be used for another purpose...otherwise you're agreeing to give away personal information." (P6) [00:21:53]. Finally, some participants highlighted that personalisation should be accessible, and would improve their engagement with the app;

"I feel like it's pretty fine because then you're probably more likely to respond or react to it." (P7) [00:14:01].
"Well yes I suppose the other thing that you need, that I should mention here is I'm a wheelchair user so sitting it my kind of default setting or my only option I can't stand at all. So, but moving even changing position I think is important, yeah." (P5) [00:06:30]

Theme 2: Conceptualising Sitting and Movement

The central organising concept is "sedentary behaviour", and participants indicated that their environment at university or home could be a facilitator SB engagement;

"Right, well and working at home, I tend to work in a bed with my feet up on my laptop so I probably I'm very comfortable in that position and would stay there for longer. And I think working in the library I tend to go up and move around a bit more." (P8) [00:05:09]

There was a consensus that SB could not be actively controlled via an app during lectures, however in the office, library and more private places it could;

"Harder would be like in the middle of a lecture because you feel compelled to not stand up. Which is why one hour breaks are pretty good. Easier is like when you're working on your own. You can just get up and move about, you're not confined to any stigma of moving about, you can do your own thing." (P7) [00:04:47]

"Well yes it could. I guess if you're if you're in a lecture that might not be possible because the rooms are smaller and you can't and it's not really protocol to start walking about in a lecture. And so that would be a, maybe you couldn't respond in that situation. In the labs again if it's if it's being taught, it would." (P5) [00:22:11]

"In the library, no, but not in a lecture, because I guess you can't stand up in the middle of the lecture and leave. In the library if you're just studying, you have the freedom taking more breaks." (P6) [00:14:20]

On the contrary, some participants did not feel restricted in terms of moving regularly as prompted by the app, regardless of their environment at the time; "If I feel uncomfortable I will definitely move irrespective of the app." (P4) [00:10:35]

"There's never a hard limit or a restriction really like if you need to get up and move then you have to get up move like. Even if it was a like if it was in the middle of lectures or something you can still get up and go to the bathroom or something." (P7) [00:17:29]

Indeed there was a suggestion to "potentially develop specific themes like a library, lectures, labs or whatever your day involves." (P6) [00:15:48]

In terms of desk-based university related work, the participants all agreed it was 'good' to move often. However, the workload or concentration on the task at hand was often a barrier to moving;

"I definitely think it's important because you do things especially if you're sitting at your desk and you're working on project work. You will literally just keep going until somebody comes in and interrupts you and something good happens. So I think it's important. I might just have my lunch at my desk as well so it actually make sense sort of eight hours of literally not moving unless you're going to the kettle." (P2) [00:05:32]

"I don't consciously think about it. Probably you know, might be about two hours before I move." (P8) [00:04:26]

"It just depends how much work, if I've got a lot then I would be less likely to leave my desk." (P2) [00:07:32]

Most only moved in response to physical cues such as pain in the body or needing a drink or toilet break as opposed to consciously moving for the sake of reducing SB;

"I typically move if I start to stiff or sore. I have a back condition so, if I start to feel achy I usually get up and around then. I fidget a lot so I usually move a lot anyway" (P3) [00:03:58]

"Because I think that after a couple of hours your knees and legs start hurting, mine at least." (P6) [00:03:58]

"To take it's more to do with my eyes. I always consciously think of my eyes I get my eyes a break but I know it's good to stand up and especially give your mouse arm a rest." (P1) [00:05:38]

Another articulated the lack of 'culture' for movement during work or university activities;

"Well if you're in a focused lecture or a work meeting or whatever, you can't respond to it and both those things lectures or work meetings can go on for about two hours...Although people are aware of it within the organizations...there's not a culture of, right we've been sitting for half an hour now...let's get up and move around. So they might do after an hour but what they tend to do is bring in a drink and people are still sitting and working during that time. So they move around but it's not encouraged." (P8) [00:18:54]

Indicating that sometimes the barriers to address SB is beyond an individual's control. An important sub-theme raised was SB's link to other conditions for example, on participant stated "I'm aware of the...physical impacts of it that but actually like their psychological and their like the efficiency or mental efficiency or I say like getting away from your desk can actually you know maybe help you." (P1) [00:11:10]. Another felt SB was closely attached to posture and ergonomics could be a solution, "the university set up here is Okay in a sense but the chairs are ergonomic chairs we use in our office would have been good and the distance between the lecturer or the blackboard and the student needs to be a bit more further...and the chair design needs to be ergonomic." (P4) [00:05:38]. Finally, one participant linked frequent SB breaks as a remedy for depression;

"So I definitely think it's something that could curb depression a little bit...... Because if you're the kind of person that gets stuck down and that sits down to do work and you're kind of, your mentality is to not leave until that work is done." (P7) [00:07:50]

Theme 3: Emotive Language to Describe Notifications

The central organising concept is "control over the frequency and type of interruption"

Participants indicated that they had experienced self-empowerment when in control of the notifications they receive, highlighting a 'tolerance' for 'modifying behaviour' that 'feeds our needs';

"Well it's me that set them up. So most of the time I'm tolerant of them." (P8) [00:15:29]

"And also the process of inputting in what you want it to remind you about I think goes to that process is probably quite beneficial to further put it in your mind on what you want to be focusing on implementing the process of actually tailoring the app to you is probably quite good for modifying your behaviour... Like if I've put the effort in to modify it and make it fit me, I'm probably going to be more invested in it" (P2) [00:16:53]

"I think I will be more engaged and would likely follow up on it. We'd use the app more. If we felt that it really feeds our needs." (P6) [00:11:56]

However the subject of notification was also met with strong feelings of negativity across all participants, with participants not wanting to an app to be 'bothering me to the point of frustration', or being 'disturbed', as the notifications become 'annoying', 'fed up' leading to them to being 'selectively disabled' or 'ignored';

"Then obviously you know like a short maybe three blip buzz, you know something that's short but you know it's obviously it's a balance between obviously letting me know that something's happening but actually or prompting me to do something and then not sort of bothering me to the point of frustration." (P1) [00:23:54]

"Mm hmm. Yeah I do ignore them. So I think the reason I ignored them would be that I'm involved in something that I don't want to be disturbed." (P8) [00:13:20]

The participants spoke about the motivation and intention to engage with an app, however the frequency of notifications could cause them to remove certain apps;

"It'll pop up saying do X amount of exercise but I often hear my phone vibrate, check it and then just ignore or remove it because it's becoming more annoying than useful." (P3) [00:09:30]

"I don't want to be notified all the time due to the intrusion of time. I mean because sometimes I'm in between doing some important work. I have selectively disabled notifications on my app for my convenience. I don't allow apps to dominate that." (P4) [00:11:15]

"I guess the annoyance factor would be something. I think would have to be managed quite well so that it would encourage you but without being, I don't know, just turned into a nag or too nagging on you." (P5) [00:14:22]

Theme 4: Confidence and Trust in the Digital Health System

The central organising concept is "confidence in the digital health system"

The participants were knowledgeable about issues surrounding data privacy and the importance of it;

"Yes. I do realise that agreeing to personalisation you're agreeing to give away some data about yourself, but it should be a confidentiality agreement between the app provider and you." (P6) [00:21:31]

In terms of the analytics that could be performed on any data the app might collect, one participant highlighted the need to have "an efficient mechanism to analyse and use those data." (P4) [00:30:56];

"whenever the data collection, these apps these apps will only help when you are efficiently doing data analysis and data storage. Again an even bigger concern with these apps is that the data is not always protected. So whenever you are trying to store data of so many users, you need to ensure that this data are absolutely protected, in the Strathclyde cloud or whatever." (P4) [00:30:00]

Some participants noted that recent innovation in machine learning could use personal analytics to deliver real-time personalised data to the user,;

"'Why don't you stop what you're doing and have a walk in the fresh air?' So I think if that app understood in a real-time then that's a key thing in a real-time basis." (P8) [00:28:13]

"The notification should not be static. The system has to be learning, so whatever feedback I'm submitting, the next time I get that notification, if there is any data, the system be able to access that...... Yeah. If I'm being personalised, my expectation is that the app I am using will also send notifications on learning basis. (P4) [00:18:38]

"Yes that would be it, yes. I mean that would learn you know maybe from over time from what the person is doing but also will know that they're changes in behaviour.... you would quantify that their behaviour has changed that they've followed the program that they're less sedentary because they've used the app." (P5) [00:17:00]

Three participants felt that data analytics could also be conducted to measure the performance of the app at across the campus population as well as trends in their overall health;

"I would like to see patterns of behaviour, to see how long people well students specifically are sitting daily, how long they're engaging with exercise. And how this affects their mental well-being. How this affects your physical their well-being. Yes of course it's not just physical well-being when you sit for so many hours...maybe like change other stuff like the length of the lectures. Many changes." (P6) [00:25:33]

"I would say that because you would be able to know how often it's telling people when to move, you have the data so you can tell where they could potentially be moving more. And that will give you a kind of indicator of the performance of your app as well...for your own benefit if you can get that data you can tell how effective your app is being as well." (P5) [00:31:01]

Especially with a new generation of young people entering university in a more sedentary lifestyle;

"Yeah I think that's hugely beneficial. I think the takeaway is that just as you say because of age groups and attending university. And I think there's the health risks are very different from you know what people's health risks were 30 years ago. So some of the key illnesses such as diabetes you know type 2 diabetes, and we're probably going to have a lot of young people coming into university who have had a history of obesity. So that's a shift that is different now. So there's some illnesses if you like that we need to use this opportunity to get more information about and address...If young people coming into university who have had a sedentary childhood actually." (P8) [00:35:41]

Finally the participants raised the issue of trust that the data is being used for a specific purpose;

"If it's just hoarding data for no reason... I'm not keen on that." (P3) [00:29:12]

"If it doesn't ring alarm bells like if it doesn't seem really personal or private stuff it wants to track for example if an app can track how far I've walked and it does it based on steps from the phone as a GPS I don't really mind as long as I was getting some benefit from that. But if it was doing it for no reason like for example if YouTube started doing it I'd be a bit concerned." (P3) [00:27:40]

"If it's pulling data from somewhere that really depends how intrusive it could be. For example if it was pulling it from a Facebook profile or something. You'd need to worry about that." (P7) [00:15:39]

and confidence in the credibility of information given by the app;

"Health apps are very important but again there has to be some kind of standardisation of being reserved and I need to trust the data it's showing...I don't want that app to puzzle me, I want that app to help me improve my life. And that can only happen if I trust the data and if I trust the recommendation. And trust comes when it gets verified, or it gets approved by a recognisable body like the NHS or big heavy weight health organizations." (P4) [00:14:30]

"Yeah absolutely because I mean if you're giving you know you want to explain and the reasons for the app so if you can get more information directly that would give, well you're not just telling people 'use this app', you're telling people why they're why they should use the app and the benefits." (P5) [00:26:18]

Theme 5: Desired anti-SB app features

The central organising concept is "engagement and behaviour change techniques". The participants articulated the anti-SB app features that might keep them engaged with it, for example having charts that document their anti-SB journey over different periods of time;

"I'd definitely look back upon because I'd want to see that progress over time. If you were to do it would be something that would actively improve my behaviour." (P3) [00:30:15] "I think it would be good if you kind of tracked and logged how many times in a working day you did get up and walk around. That would require a lot more effort from the user. And I know myself I would not do that, so to get the most out of it you'd have to put in all that information but I wouldn't. I'd just used the app as a kind of reminder as opposed to a means of me recording stats every day to be honest with you." (P2) [00:24:33]

"And at first it was interesting and engaging but as I was saying it became tedious and It felt like all it was doing was just listing things I ate and then pointing out that there were faults. So there wasn't much change from that. I was just doing it and there was no benefit so I deleted it." (P3) [00:06:54]

This is consistent with research on voluntary self-tracking for health and fitness, which claims that people respond to personal data generated in varied ways; while some users may gain a sense of control over their bodies via the monitoring of certain bodily statistics, other users may not find that information useful or applicable leading them to become bored with the device, (Lupton, 2016)

Setting goals was mentioned as a motivator;

"I think the goal setting is good. I mean sometimes people don't stick with it. I think initially it's fine. It's always a starting point you know and if you can manage to make that. I think maybe putting awards in, so it maybe yourself that has to provide for the awards." (P8) [00:30:18]

"So for me if it's an app about getting up and moving I'd maybe once some sort of reward for complying to that behaviour it wants me to do so rather than just saying get up am move around with no benefit. There's a lot perceived benefits like doing exercise, doing the walking and getting better. For me because there's no instant reward it's more 'Oh that was great. Five minutes'. (P3) [00:25:15]

As well as fun elements like virtual awards;

"I think you don't want something that's too scientific. You want a little bit of an element of fun." (P5) [00:32:43]

"The app itself is set for the number to steps. And so this is ones that are set for all of them in Scotland so you could technically do all of it you know walk across the Sahara desert or something like that... I think the virtual reality thing is really big and virtual reality is probably what I mentioned is more about imagination. It might be slightly off the subject but there are virtual apps now that you can actually walk up Ben Lomond and you're seeing the scenery or you're standing on a treadmill or whatever." (P8) [00:22:17]

Finally, to ensure continued engagement with the app, the participants underscored the need for a simple digital system that is easy to navigate;

"But if it's just a self-contained within the app, maybe it calls it from - like if it's integrated with the university it would have access to your time-table so it would know if you've been sitting down for an hour or two hours. So it can tell you if you're in a two hour lecture to get up and move about." (P7) [00:15:39]

"Would be useful. It would be good if I could log, all right this is me starting work or this is me I'm now sitting at my desk, press a button so it knows you're sitting at your desk. And then it would pop up after you've alerted it, if that makes sense?" (P2) [00:23:28]

"Yeah. Well ease of signing up. You know that sort of how I get on board. It is you know that's what I really like. I think it's I think it's really good use of technology to simplify the on boarding process." (P1) [00:21:50]

One participant spoke about the simplicity of the app he was currently using and the possibility of the app becoming more advanced in a manner that allowed its users to 'advance' with it;

"I don't know if I could compare to the Pokémon Go app. I mean look at that now it's not a very simple app with lots of different layers of features but yeah I think because it started off simple. And they built on it slowly for people, lots of the people have stayed on it so over the course of a few years it's slowly improved." (P3) [00:25:15]

Theme 6: Accessibility

The central organising concept is "inclusive technology". One participant spoke about how 'reminder apps' for SB are geared towards people that can get up, stand and walk around.

"Well yes I suppose the other thing that you need, that I should mention here is I'm a wheelchair user so sitting it my kind of default setting or my only option I can't stand at all. So, but moving even changing position I think is important, yeah." (P5) [00:06:30]

He reflected on his personal experience with movement in relation to a potential anti-SB app;

"Well, for me not vibrations. I mean if my phone is in my pocket I don't feel it. So vibrations don't really work for me personally but it does have to be a flashing LED or a message pop up on the screen you know just in the same we actually get notifications for text messages and emails like that." (P5) [00:28:04]

He highlights his vulnerability/susceptibility to SB and how movement is a conscious effort;

"I mean I guess I'm more prone to just sitting here because I don't feel any sensations of that I've been sitting for too long. Really. So I guess I guess it's up to me to just be aware that I should take some pressure remove a little bit....maybe and stretching a leg or changing position can help that. (P5) [00:07:01] Well.

"so I think that there's something in there to you know specific for wheelchair users, just a reminder." (P5) [00:35:06]

Theme 7: University of Strathclyde brand is acceptable and respected

The central organising concept is "sympathetic design for the existing brand". There was an acceptance of the university's existing app and perhaps a call for the university to be more active in any anti-SB endeavours as it is on other health pursuits, for example the participants were aware of the university's efforts to promote sports and well-being such as "cycling" (P1), "mental health awareness" (P2), "sports and classes" (P6). However in terms of SB awareness at the university, one participant captured their thoughts;

"Not that I'm aware of. It's not really something I've really thought about before though. I've not seen any outright like things saying that you should take a break from studying. I do think it's important." (P7) [00:05:31]

Another noted the importance of educating people about what the app aims to achieve;

"More than the design I feel that if you are introducing any app or new app to the students they then need to understand what's being talked about. So one session like what are the good practices or the good postures, we need to have a personal video or one to one for the students so that they understand what this app wants to do so on this once they know that this is an equation and it is a notification or this is the thing that app wants to achieve." (P4) [00:20:10]

All the participants, except one felt the app should be in-keeping with existing design of the University of Strathclyde's app;

"like if it's integrated with the university it would have access to your timetable...The Uni apps that they right now are pretty alright so it was something I can interface with the university app that they have, and that was kind of a tile app within the app if you know what I mean?" (P7) [00:21:42]

"if it's to do with university it uses my university single sign on page so automatically it just prompts me to click ok, that would be good." (P1) [00:21:04]

"Yes. You know, it wouldn't have to deviate too far from the theme that they already have there, it seems to work quire alright." (P7) [00:21:57]

One felt that if the app was developed properly and was accepted by the university it could be useful, and the concept could be extended beyond Strathclyde;

"I think this app should be acceptable in fact this app will have, we already have the university app, we could put a link up there, we can advertise there. That has to be some kind of acceptability from the University also, that this kind of app is available. And I personally think this should be useful. This really should be in future this can be extended to any number of universities. Or any number of situations actually." (P4) [00:28:59]

However, one participant felt the app should be a different brand to the university, in order to attract more young people;

"Yes. I'm not sure, see what they've done around sports at universities, they've always gone for a different branding. So I'm just kind of familiar with that, and the findings seem to be you've got your universe logo, but for sports to attract young people - so we may be talking about a different group of folk - but to attract young people they're different apps...I think they want to see it as being something that is slightly separate from University." (P8) [00:35:17]

7.0 Conclusions

Semi-structured interviews were carried out on 8 participants to meet objective two. Using a reflexive thematic analytics approach, one overarching theme was identified; *personalisation*. In the context of anti-SB apps, users wanted the intervention to tailored to them from the type, sound and frequency of notifications, to the real-time advice on when and how often to move when managing SB. The way the the users conceptualised SB was broad, inclusive of psychological as well as physiological effects. Incidentally the decision to move, when sitting at a desk in a university environment (or at home) was not led by the conscious need to reduce SB, rather it was bodily pain or the need to have a drink/toilet break.

Discussions around notifications are a crucial aspect of an anti-SB intervention, and the users at times took a negative tone towards it. Of the 8 participants interviewed, only one turned their notifications on. The rest described them as annoying, disruptive and intrusive. Finally, the users perceived an anti-SB for the university as a positive intervention, however stressed the importance of data privacy. The barriers related to anti-SB apps were notification and accessibility related. The facilitators were grounded in improving well-being. An important outcome noted the participants was the potential of the analytics of 'Big data' that could be performed on the personal information collected by and snit-SB for the benefit of the university.

Chapter 5: Requirements Gathering

5.0 Introduction

This chapter presents a rationalised and prioritised set of requirements for a digital health solution to help staff and students manage desk-based sedentary behaviour at the University of Strathclyde. Data gathering, such as feedback on potential solutions from target users is a central activity in the IDEAS framework and occurs iteratively in all ten steps (Mummah *et al.* 2016). The chapter's aims are twofold; first, to understand the target users' activities and the context of that activity so that the digital health solution can assist them with reducing SB. Second, to establish stable requirements that support the design process.

5.1 Establishing the Key Requirements

To begin, the author reflected on the needs of the target group. Using the Four 'W's question technique, the author sought to convert the findings from the empathise stage into a meaningful, actionable problem and design statement;

- 1. Who is experiencing the problem? Staff and students at the University of Strathclyde
- What is the problem? Desk-based sedentary behaviour due to the nature of their study and work obligations.
- 3. Where does it happen? The context varies, but the physical activity (SB) occurs when the users are at their desks i.e. library desks, office desks, lecture desks and so on. In the interviews, the target group referred to contextual information such as the office environment, the library, their workload, and the number people around them. These include issues of usability, accessibility and social acceptability factors.
- 4. Why is this problem worth solving? Based on the best current evidence on SB, the UK government states that all adults should minimise the amount of time spend being sedentary (sitting) for extended periods. It can be improved by regular, short breaks. The value it brings to the University of Strathclyde (business) would improve the health and well-being of the campus population. The value it brings to the user is improved personal health and well-being.

5.2 Problem and Design Statement;

"Our staff and students have the problem that desk-based sedentary behaviour is inevitable in university settings due to the nature of their work and study obligations. The impact of which may be adverse health problems. Our solution should deliver a personalised digital health tool that can help them manage desk-based sedentary behaviour by providing regular, gentle reminders to break up sedentary time."

5.3 Stakeholders

To realise the potential of the digital health solution, it was essential identify the key stakeholders and explore how they might be affected. The key stakeholders were prioritised into four groups (see Figure 5);



Figure 5. Prioritised Stakeholders of the Personalised Digital Health Solution for Managing SB.

First Priority Stakeholders: Students and staff at the University of Strathclyde. They are the key stakeholders, who will be using their personal smartphones to interact with the personalised digital health solution.

Second Priority Stakeholders: e.g. Digital health researchers may access the data generated to improve studies on the reduction of SB in university settings.

Third Priority Stakeholders: e.g. The UK economy. It has been established that SB-related mortality and morbidity costs the NHS billions of pounds per year. Any type of intervention that can reduce this burden on the NHS may be of value.

Fourth Priority Stakeholders: e.g. Other health promoting universities, colleges and schools. This type of technology may prevent SB –related illnesses in children and young people.

Other important stakeholders to consider include the government, cyber health investors, charities, software developers and ergonomic designers. They are all affected directly or indirectly and in the case of developing this product any further, all of these key stakeholders will need to be represented and consulted.

5.4 Market Analysis of Competing Products and Identified Gap

The author carried out a rapid market analysis on existing anti-SB apps that may be competitors to the potential digital health solution under study. Using the search terms 'sedentary behaviour', 'sedentary behavior', 'reminder' and 'breaks', the author identified 23 apps on the Google Play Store that were directly to sedentary behaviour.

While the search and data extraction was not as sophisticated as Shoeppe *et al.* 2017 and Dunn *et al.* 2018 (both of whom systematically searched the Apple iTunes and Google Play for anti-SB apps before coding them for behaviour change techniques) it still served a purpose; identifying a gap. The author's search was also on Apple iTunes and Google store. In terms of criteria, an app was included if it was available on a smartphone, had 3+ ratings, featured alerts to break to sedentary behaviour and allowed the user to have some personalised features. Of the 23 selected only one had accessibility features, all were office based and users generally had poor comments about notifications and only one had utilised theory in its design. While of them were office based, none of them were geared specifically for students or campus health. The present product will aim at filling this gap.

5.5 User Context: Personas

Personas, including user stories and scenarios were developed from the target user interviews and literature. The author aimed to create detailed, realistic examples of how the users might interact with the system. Six student/staff personas were developed, and each one served as representation of the most essential user groups. They were useful to evaluate potential design ideas, including how tasks might be performed. Below, the key characteristics of each persona is highlighted, as well as their typical tasks and regular 'modes'. Mode refers to the location on campus where the user spends most of their desk time.



From **Damian's user story**, he wants to be able to set his own goals and have fun with the anti-SB app.

Typical task for users of this persona: "Find your personal profile and look for the unlocked feature and rewards you've earned."



From **Frederick's user story**, he wants to monitor his SB journey, and wants the anti-SB app to be accessible for his needs i.e. not reminding him to stand, but rather move.

Typical task for users of this persona: "Find your monthly insights and reflect/review your anti-SB journey."

Regular Mode: Lecture Mode



From **Charlotte's user story**, she wants to be notified gently by the app, and not cause annoyance or interruption to those around her.

Typical task for users of this persona: Set their own tones, sounds and are conscious of their surroundings. "Find the 'Library Mode' and set a gentle reminder."

Regular Mode: Library mode

Jonathan Kelly



- From Jonathan's user story, he wants to know that his personal health data collected by the app is safe and secure.
- Typical task for users of this persona: Open the phone and check for software and security updates, offers feedback to the app provider regularly.
- Regular Mode: Office Mode

		Resilient Loyal Athletic	Motivation
		Goals Continue inspiring people across campus to get fit and 	Incentive Fear
	-	healthy Make an independent film on cycling!	Growth
		Ensure Strathclyde remains an active health promoting	
"Persistence	can change	university	Power
achieve	ments"	Learn Greek	Social
Age: 44 - 54 Work: Professor in Location: Scotland Personalit	Sports Science , UK y Extrovert	 Frustrations Notifications are utterly annoying when tasks are time- bound I spend most of my days sitting, even though I cycle to and from work, I'm mostly sedentary! Health apps don't always have verified, credible information. 	Brands & Influencers
Thinking	Feeling	information	David Loyd Con Health & CA
Sensing	Intuition		Maldon Film Club
Judging	Perceiving	Bio and User Story	
		Elle has been a professor in Sports Science for over 10 years and enjoys the new challenges with big data and analytics for	Technology
		health improvements. She cycles to and from work. Her hobbies include swimming and watching independent, foreign films.	Digital Health
			Social Media Platforms
		"As a user, I want the app to link to up-to-date, verified health websites so I can access credible data for sedentary habits. The app should utilize Strathclyde university's current mobile app as	The Internet

- From Elle's user story, she wants to access evidence-based research and stick with the current Strathclyde app.
- Typical task users of this persona: Want to access up to date evidence on health advice.
 "Open the app, and look for the 'NHS' button. This leads to the NHS website and access to credible information'
- **Regular Mode**: Office Mode

lessica Pearson		
The wasn't built in a day."	Activist Smart Optimistic Goals . . Protecting my health and well-being . . Completing my MSc degree . . Travelling to Rio! . .	Motivation Incentive Fear Growth Power
Age: 25 - 34 Work: MSc student Location: Scotland, UK Personality	 Frustrations I spend my whole life sitting! I'm often too busy studying to stand up and walk around. Current anti-sedentary apps are too demanding! 	Social Brands & Influencers
Introvert Extrovert Thinking Feeling Sensing Intuition Judging Perceiving	Bio and User Story Jessica is passionate about travelling and digital health gadgets/ apps. She spends most of her time behind a desk in the library or in her office. She is about to complete her MSc and hopes to work in digital health literacy following her travels.	Digital HEALTH & CARE INSTITUTE
	"As a student, I want an app that automatically reminds me to move so that I don't get stuck in one seating position for too long. This takes out the effort of reminding myself to move all day".	Technology Smartphone Health Apps Social Media Platforms
		Health Gadgets

From Jessica's user story, she wants to apply minimal effort when using the anti-SB app.

Typical users of this persona: Are excited by the brand. "Open the app and link with your university time-table, so that the anti-SB app can automatically make break suggestions."

Regular Mode: Library Mode

In conclusion, these personas represent the characteristics, needs and wants of the target group interviews in Chapter 4. Their user stories can resonate beyond these charts and were useful in thinking about how the digital health solution could remain simple and clear, yet sophisticated and intuitive.

5.6 User Requirements Method

User requirements were linked back to the research question and drawn from:

- Semi-structured interviews with real users -(chapter 4)

- Literature review (Chapter 2)
- Personas
- Sample is small, and not generalizable to the target group or the university, indeed requirements gathering with a different target group may generate a diverse or distinct set of requirements.

Collectively, these became the requirements presented in the next section.

5.7 Findings from User Requirements: Design, Data and Environmental Requirements

Table: 3. Functional Requirements (Moscow Prioritisation)

ID	Task	Must Have	Should Have	Could Have	Won't Have	Requirement
						Origin
1	the system should know					
	when and how often to	х				Interviews
	prompt a user to move					
2	it should accurately time					
	when the user begins to	х				Interviews
	move and when the user					
	stops moving					
3	challenging for a range of					
	user abilities		х			Interviews
4	should contain some					
	games or virtual activities					Interviews
	form a rewards system			х		
5	the system should	х				
	configure to different					
	physical locations at the					Interviews
	university (e.g. different					and
	modes – library, office,					Personas
	labs, lectures etc.) and					
	personas were reviewed.					
6	Personalised	х				Interviews
						and
						literature

7	the data must be reliable,	x			Interviews
					and
					literature
8	up to date, real-time and	х			Interviews
	accurate				and
					Literature
9	Can chart their SB history			х	Interviews
10	Links to the NHS		Х		Interviews

Table: 4. Non-Functional Requirements (Moscow Prioritisation)

ID	Task	Must Have	Should Have	Could Have	Won't Have	Requirement
						Origin
1	the system should run on					
	iOS, Android and	x				Literature
	Microsoft platforms					
2	be security based					
	(possibly linked with	х				University
	StrathCloud).					
3	Business Continuity		х			Literature
4	'Tile app' Strathclyde					Interviews
	Branding and Existing app	х				
5	NHS Health App and	х				
	Digital Tool Assessment					Literature
6	Care Quality Commission	х				Literature
	Prompts for Digital					
	Healthcare Providers					
	(CQC, 2017) or NHS app					
	or MRC					
7	Safe data, privacy and	х				Literature
	storage and use					and
						Personas
8	Simple, not require much		х			Interviews
	effort or inputs.					
9	Potential to be used for			х		Interviews
	advanced analytics that					
	would benefit the					
	university in terms of					
	structuring					

10	Accessibility	x		
11	Usability	х		
12	Data retention	х		

5.8 Conclusions

This chapter aimed to gather some functional (processes, information and interaction) and nonfunctional (security, usability, business continuity) requirements for the anti-SB app. The MoSCoW prioritization technique was used for managing the requirements. Where MoSCoW is an acronym for 4 different categories of initiatives: must-haves, should-haves, could-haves, and will not have at this time. These requirements will be used in the design process.

Chapter 6: Prototype Design and User Evaluations

6.0 Introduction

In the IDEAS framework, the ideation, prototyping and gathering user feedback (evaluation) is a rapid, iterative phase. This chapter follows the process of ideating, low fidelity prototyping (with user feedback evaluations) and high-fidelity prototyping (with user feedback evaluations). In doing so, it aims to fulfil objective three: Design and evaluate a high-fidelity prototype (anti-Sedentary Behaviour app) for a university setting. The chapter draws on findings from the literature review (Chapter 2), target user interviews (Chapter 4) and requirements gathering chapter (Chapter 5). The output is a clickable High-Fidelity prototype which can be found here: https://pr.to/9TNOA5/

6.1 Revisiting the Problem and Design Statement

"Our students and staff have the problem that desk-based sedentary behaviour is inevitable in university settings due to the nature of their work and study obligations. The impact of which may be adverse health problems. Our product should deliver a personalised digital health solution that can help them manage desk-based sedentary behaviour by providing regular, gentle reminders to break up sedentary time."

6.2 Important Inputs from the Literature Review, Target User Interviews and the Requirements Gathering

Considering the *Problem and Design Statement* mentioned above, the author identified some key inputs from previous chapters, and used them to begin the design process;

- Findings from the **Literature Review** (Chapter 2); Desk-based SB can be reduced with apps that provide regular prompts to move. Personalisation features and behaviour change techniques can enhance app engagement.

- Findings from the **Target User Interviews** (Chapter 4); The target users valued personalisation (the personal benefit of the solution was underscored), they conceptualise SB as

related to psychological as well as physiological conditions, the University of Strathclyde App was a useful way to integrate the anti-SB solution (the brand is reputable and respected), smartphone/app notifications was an emotive subject (users wanted gentle reminders), the anti-SB solution should be accessible and they wanted to have confidence and trust in the system (confidence that their data is safe and trust that the information provided from the app is reliable).

- Findings from the **Requirements Gathering** (Chapter 5); (functional) the system should know when and how often to prompt a user to move; it should accurately time when the user begins to move and when the user stops moving; challenging for a range of user abilities; should contain some games or virtual activities form a rewards system. (Non-functional), the system should run on iOS, Android and Microsoft platforms; be security based (possibly linked with StrathCloud). (Data requirements), the data must be reliable, up to date, real-time and accurate. (Environmental requirements), the system should configure to different physical locations at the university (e.g. different modes – library, office, labs, lectures etc.) and personas were reviewed.

6.3 Design Approach

The overall design approach was guided by steps 4 (ideate), 5 (prototype) and 6 (gather feedback/ evaluations) of the IDEAS framework (Mummah *et al.* 2016). This step was concerned with focusing the ideas generated around sedentary behaviour and behaviour change techniques (namely goal setting, personalisation and virtual rewards).

6.3.1 Sketches, Wireframes, Colour Palettes, Interface Design and Branding the App

From the information in section 6.2 above, early thoughts and ideas were sketched along with alternative designs. A colour palette matching the University of Strathclyde's brand was selected.





Figure 6. Sketches and ideas

Royal	Space	Prussian
HEX #11166C RGB 17:30:108	HEX #102951 858 29 41 81	HEX #003152 R08 0 49 82
Navy	Yale	Egyptian
HEX #000080 BGB 0 0 128	HEX 8054092 RG8 14 72 146	HEX #103480 RGB 16 32 106
Azure	Sapphire	Olympic
NEX FOREFT ROB 0 128 255	HEX ROFISION RGB 15 RZ 180	HEX ROOMECC MIGR 0 142 204
Cornflower	Independence	Teal
NEX 0555375 RGB 101 147 245	HEX #8C5160 RG8 76 83 109	HEX #008081 RGB 0 128 129
Maya	Pigeon	Turkish Blue
NEW PORCHE NEW TILLING (CT.)	HEE 47281AS RGB 114 133 105	1423 448 9224.3 1658 294 131 140
Carolina	Steel	Tiffany
HEX H57A003 RGR 07 (H021)	HEX BAGE2DK KGB 70 130 TBD	HER BETCHCO HUR 124-214-208
Baby Blue	Air Force	Electric
HEX 489CFF0 RGB 137 207 240	PEX actionAd RGB IIII 139 174	HEX #7579/FF RGB 126-249-255
Sky	Powder	Turquoise
HEX PESCIENE RGB 149 200 216	HER HEODERS	HEX #JFEODO









Sketching the interface design allowed the author to explore how the concept of 'timing' and 'timers' were depicted symbolically. The idea was not to make the users feel anxious about being constantly timed, but to imply it through a symbol. The author decided on the water timer; symbolising the measurement of health and well-being (SB)

The activity outcome was a series of sketches, with possible tasks and functions. The colours were established, and the brand image was tested. Care was taken to remain sympathetic to the users' needs and the Strathclyde brand.

6.4 Prototyping

Prototyping is a central activity in the design process. It is often used to test a product's visual design, content and interactivity before it is built (Preece *et al.* 2015; Babich, 2017). In the IDEAS framework, early prototypes are used by researchers to observe participants interacting with the digital health intervention. Participants are encouraged 'think aloud' and speak during the process.

Prototyping sits on a continuum; one side are low-fidelity (lo-fi) cheap, paper type versions of a product and on the other side is high fidelity (hi-fi) where the product feels and acts like the final product (Babich, 2017). The next section shows how the app was branded, and presented to real users via lo and hi-fidelity prototypes.

During the prototyping phase, the author named the anti-SB app so that users could recognise its link to sedentary behaviour. Indeed one participant stated in the interview;

"So anti-sedentary app sounds a bit... I know that isn't what you would call it but even just that language is quite off putting...So and, I mean as you know that there's a lot of apps on in the market. So a snappy name I think helps like 'Up and About'" (P8) [00:21:04]

In the design of an anti-SB app, Rutten *et al.* (2013) advice on using a recognisable sedentary-related term as a 'prerequisite' for the success of a digital intervention. They list three criteria as the characteristics of an effective brand name;

- 1. The law of the few (requires certain people to spread it, e.g. experts, the university)
- 2. The stickiness factor (the term should be memorable to drive people to action)
- 3. The power of context (its success depends on the circumstances of time and place)

Rutten *et al.* (2013) claim that meeting these criteria will make the app more memorable and encourage people to move often. This was an important part of the early design process, and the author spent some time thinking up a meaningful acronym that was relevant and memorable. It was decided that the "Strathclyde University's 'Design-Enhanced Sedentary Kit'" or Strath DESK! was worth testing with users as it seemed short and snappy. The exclamation mark was initially added for emphasis, but later kept as part of the design following some feedback. The acronym DESK was an obvious representation of the health issue under study; 'desk-based sedentary behaviour'.



Figure 8. Is the tile app for Strath DESK!

6.4.2 Creating the Low Fidelity Screens on Proto.io. (a prototyping software)

The outputs from the sketch phase above, were a useful starting point to begin the paper prototype. This was done using an online software called Proto.io (Proto.io, 2019). The software allowed the author to place some images into an iPhone X template, making the ideas appear more concrete. The decision to design the app on the iPhone X template was due to ease and familiarity.



The app's main tasks were:

- Allow a user to securely access the app through the University's main mobile app
- Allow the user to manually set up the mode (area of the university where they are seated library, office, lectures, labs). Based on the user's instructions, the system would prompt them to move when it senses the right time to do so. When the 'movement time' is over, (approx. 3 minutes) the system alerts the user accordingly.
- Allow the user to automatically link to their existing university timetable and have the system suggest breaks based on their agenda for the day. When the system senses it is time to move, it will let the user know through a sound/haptic of their choice. When the movement time (approx. 3 minutes) is complete, the system will let the user know.

A fully annotated display of the low fidelity is presented below in two parts. Part one shows the user how to enter the tile app through the university's existing system. Part two shows the user how to enter and navigate Strath DESK!

PART ONE: How to install Strath DESK! on the University of Strathclyde's Mobile App



Screen 1: iPhone X Home Page



Screen 2: iPhone X App Page



Screen 3: Opened Strath App Page



Screen 4: 'Add Something' Strath App Page

FIXED ITEMS			
Now & Next			
My Notices	\odot		
YOUR PREFERENCES			
Events			
Find a PC			
Exam Timetable			
Strathclyde Sport			
Class Timetable		(Find the 'Strath DESKI' Ti
Strath DESK!			
Book Group Study	\bigcirc		
Strath Union	\bigcirc		

Screen 5: Strath App Add/Remove Tiles

Press 'Back' to see Strath	14:42 Back Add/Remove	rt (40 =)	
Перктанцен	FIXED ITEMS		
	Now & Next		
	My Notices		
	YOUR PREFERENCES		
	Events		
	Find a PC		
	Exam Timetable		
	Strathclyde Sport		
	Class Timetable		Slide to add Strath DESK!
	Strath DESK!		 On the tile list
	Book Group Study		Contine the list
	Strath Union	\bigcirc	
	Sports Union	\bigcirc	
	Logout	\bigcirc	
	Useful Contacts		

Screen 6: Strath App Add/ Remove Tiles (now with Strath DESK added)

14:42	at 40 🗐	
1 0	-	
My Notices	Events	
-	—	
Find a PC	Exam Timetable	
*		
Strathclyde Sport	Class Timetable	
		Click on the Strath DESK!
		Tile to enter
	⊗ ≡	

Screen 7: Enter Strath DESK!

PART TWO: Entering and Navigating Strath DESK!

netlogin-dev.strath.ac.uk	
Strathclyde	Log on to the Strath
Institutional Login	DESK! app using your
To enter Strath DESKI you need to login using your University ("DS") credentials (username and	University ('DS')
password) Usemame	credentials (username
Production in the second se	
Password	
Alter betweenig	
lage	
You have been redirected here by another website, log in and you will be retarised to the site.	
Bernember to property log out of any resource, you should always end your browner session.	

Screen 8: Strath DESK! Log in Page



Screen 9: Strath DESK! Welcome Page



Screen 10: Strath Desk Main Dashboard



Screen 11: Example Automatic Breaks Linked to Personalised Timetable



Screen 12: Menu Page


Screen 13: About Strath DESK!





Screen 15: Weekly Insights

6.2 Wizard of Oz Technique: Low-fidelity Usability Evaluation

The Wizard of Oz is a popular method used for product evaluation and prototyping technologies in the Human-Computer Interaction. It is often used to analyse a partially finished product/application for improving on design. Four participants took part in the low-fidelity evaluation (p2, p3, p9, p10) individually.

All evaluations took place on Level 13 of the Livingston Tower (University of Strathclyde). Upon arrival, participants were thanked for their participation, and reminded of the research aims and objectives as per the information sheet. Participants were also reminded of consent form details and their right to leave the evaluation anytime without a reason



6.3 Feedback from the Low-Fidelity Evaluation

The sessions were filmed (hands only) and later all spoken word was transcribed by the author. The findings were placed into a table which can be found in the appendix [...]. The feedback was generally

positive, the system was intuitive, memorable and simple. You can see a version here; https://www.dropbox.com/s/795o2fjqgvbqgey/Video%2006-08-2019%2C%2015%2014%2051.mov?dl=0

However the participants were confused by two screens. They will be discussed further below.



This screen, named 'weekly insights' was intended to show users how often they 'adhered' to the app's prompts to move. The colour of each percentage was intended to represent a different 'mode' e.g. Library mode. And this where prototyping becomes essential, we all see and interpret data differently. What seemed obvious the author, was confusing to other;

[P3] so looking at this, this is my personal insights, it's a simple way of displaying it so it's not all crammed portrait. It's a nice clear layout, I'm looking at these percentages and these all add to 100% together, so is that 50% of my time spent there is sitting? I would like a little description, a way to be told this is what that is. Label for axis – 35% of what...

[P2] 50% – did I spend..erm confusing, at a library desk, not entirely sure what that 50% represents –so it's your compliance and?

[P2] Definity would follow the app. Colouring, I think the different colouring represents different places, whereas somebody else might see that and see 35% and see that its green and think that its good. Because green tends to be associated with positive, well done thumbs up whereas red is the opposite. Percentage is good, everyone could understand the percentage, it's better than a number, different people would have different percentages, visually appealing. Perhaps a dash to indicate if someone hadn't sat at their desk this week.

[P10] measuring the time I'm spending sedentary at my mode desks? I should have understood that earlier. Percentages don't add up to 100 percent- -not obvious if it was measuring time being sedentary or percentage of adherence? Based on this, the screen was changed, and instructions were added.





6.4 High fidelity prototype

The feedback (or output) from the low-fidelity evaluations were a useful input for starting the high fidelity design. There were no major changes to be made, however the participants wanted some instructions, particularly with the 'personal insights' screen. Again the author used Proto-io to expand the existing low-fidelity screens. A fully annotated display will be illustrated below, only from the start of the Strath DESK! app to avoid repetition.



The high-fidelity evaluation sessions were an important opportunity to see how the target users interacted with this iteration of the Strath DESK! app. Participants were given a task sheet with simple instructions. Two participants opted not to follow the instructions, preferring instead to rather they just wanted to navigate the app

There is still an important area that need to be refined; when the user is prompted to move, what are they expected to do? This question is still under consideration what the sedentary behaviour literature – if the user is prompted to move and they carry out an action, then that is in fact a physically active break, not a sedentary break. The implication is, a physical activity break would require a different set of instructions, for how to carry out a certain action.

The walkthrough with the three participant reviewers generated some useful feedback. It assisted with refining the design of the app, thereby improving it from its previous iteration. HandsDown was then modified based on the recommended changes identified from this first phase of testing. During the usability evaluations, the participants spoke about the app's potential adaptability to other joints in the body, such as the neck, shoulders and feet. It would be interesting to explore how feasible this concept would be.

There were limitations with the high fidelity prototype, being a 2D screen device, with a researcher does not capture the contextual environment. The next phase of research should explore how a device like this might work in the library or a lecture or an office a so on.

In the IDEAS framework, the ideation, prototyping and gathering user feedback (evaluation) is a rapid, iterative phase. This chapter follows the process of ideating, low fidelity prototyping (with user feedback evaluations) and high-fidelity prototyping (with user feedback evaluations). In doing so, it aims to fulfil objective three: Design and evaluate a high-fidelity prototype (anti-Sedentary Behaviour app) for a university setting. The chapter draws on findings from the literature review (Chapter 2), target user interviews (Chapter 4) and requirements gathering chapter (Chapter 5). The output is a clickable High-Fidelity prototype which can be found here: https://pr.to/9TNOA5/

Chapter 7: Conclusions and Recommendations

The dissertation was concerned with reducing desk-based sedentary behaviour in university settings using a personalised digital health solution. By undertaking a series of research activities with real target users, it aimed to advancing our understanding on the requirements for an anti-SB app in a local university. The main research question asked, 'how might a personalised digital health solution help manage desk-based sedentary behaviour in university settings?'. The main objectives were;

- Objective one: Review the literature on the effectiveness and usefulness of existing anti-sedentary smartphone applications (apps) and their key features (Literature Review, Chapter 2). The chapter began by setting the public health scene in which this research is situated. Modern technology has altered the way populations live and interact, leading to lifestyle conditions that require novel methods to address. One of those novel methods is anti-SB apps. Their concept is grounded in breaking up prolonged SB by reminding a user to take regular 'sedentary breaks', however the concept of 'sedentary breaks' is not entirely grounded in evidence-based research. This issue has led researchers to study the effectives of anti-SB apps, with the aim of establishing clinical effectiveness through the 'gold standard' RCT. The issue with that type of evidence, is the length of time it takes to complete, often meaning that the intervention becomes obsolete due the rapidly expanding technology health and medical app market. Other researchers are calling for more usability type studies as an equally valid measure of anti-SBs' effectiveness. The key features in in these apps are personalisation, notification types and behaviour change theory i.e. goal setting. Personalisation of health apps have been proven to enhance user interaction by motivating users to remain engaged.
- Objective two: Explore student/staff views and perceptions of anti-sedentary apps in the context of personalised notifications, including barriers and facilitators to its use (Semistructured interviews, Chapter 4). Semi-structured interviews with 8 participants was carried out to meet objective two. Using a reflexive thematic analytics approach, one

overarching theme was identified; *personalisation*. In the context of anti-SB apps, users wanted the intervention to tailored to them from the type, sound and frequency of notifications, to the real-time advice on when and how often to move when managing SB. The was that the users conceptualised SB was broad, inclusive of psychological as well as physiological effects. Incidentally the decision to move, when sitting at a desk in a university environment (or at home) was not led by the conscious need to reduce SB, rather it was bodily pain or the need to have a drink/toilet break. Discussions around notifications are a crucial aspect of an anti-SB intervention, and the users at times took a negative tone towards it. Of the 8 participants interviewed, only one turned their notifications on. The rest described them as annoying, disruptive and intrusive. Finally, the users perceived an anti-SB for the university as a positive intervention, however stressed the importance of data privacy. The barriers related to anti-SB apps were notification and accessibility related. The facilitators were grounded in improving well-being. An important outcome noted the participants was the potential of the analytics of 'Big data' that could be performed on the personal information collected by and snit-SB for the benefit of the university.

Objective three: Design and evaluate a high-fidelity prototype (anti-sedentary app) for a university setting. (Design and evaluation process, Chapter 6) To meet this objective, the findings from objectives one and two were revisited. Using sketches, colour palettes and the interview data, the 'brainstorming' phase produced some designs which were later advanced using a prototyping software. The low-fidelity paper protype was a useful method in relaying the early product concept to the user and seeing how the user responds. From the paper prototypes, the users were able to 'think-aloud' about any issues related to design and potential functionalities of the app. One screen named 'weekly' insights inspired conversation about how data is presented and interpreted, and this led to some minor design changes. Finally, the high-fidelity prototype was evaluated by several participants and received some encouraging feedback about how the app might function in different university contexts. The link to my table feature was especially welcomed by the users due to its simplicity and ease.

In conclusion, a personalised digital health solution (Strath DESK!) would help users manage their SB by delivering personalised messages and prompts to take sedentary breaks. Strath DESK! would learn from the user overtime, advancing in prompting the user to move at the right time, without letting them become de-motivated. Strath DESK! would allow the user to see were or what 'mode' they are most sedentary and make suggestions on how a users' SB could be better managed. Finally,

Strath DESK! would have the potential to perform data analytics at the personal as well as university level, to allow meaningful suggestions in health an wellbeing around the Strathclyde campus. The IDEAS proved a valuable guiding framework in establishing the research aim and objectives. Future directions should include the development of a fully functioning Strath DESK! app, the could be studied in real-time, including observing how users interact with the system in lectures, in offices, in labs and in the library.

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Appendices

Appendix 1 - Study Advert



PARTICIPANTS WANTED

Are you sitting too much in a University setting?

Can you take part in a brief telephone or face-to-face interview?

Title of the study: Reducing Sedentary Behaviour in a Health Promoting University using Personalised Activity Notifications: An Application of the Integrate, Design, Assess and Share (IDEAS) Framework for UX Design.

Introduction

Sedentary behaviour (SB) affects the health of individuals, and without intervention, can lead to increased risks of cardiovascular diseases, type II diabetes, metabolic syndromes and cancers. While several anti-sedentary apps exist, an important challenge for designers of digital SB interventions is how often to remind or notify users to engage with a health app without becoming disruptive or annoying. A suitable solution might be the utilization of personalised activity notifications, grounded in behaviour change theories. This research aims to design and build a high fidelity prototype app that monitors a user's inactivity and empirically explores how and when to notify the user that an action is required.

Why have you been invited to take part?

You have been selected because you may have insight into sedentary behaviour in a university environment – e.g. you are a student or staff member that spends most of their working day at a desk.

What happens next?

If you are happy to continue or have further questions, please email <u>Carolina Wani</u> for the <u>information sheet</u> and <u>consent form</u>. In case you do not wish to proceed, we thank you for your time and attention.

Researcher Contact Details:

Researcher: Carolina Wani: Carolina.wani.2018@uni.strath.ac.uk

Research Supervisor: Dr Marilyn Lennon: marilyn.lennon@strath.ac.uk

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Consent Form

Name of department: Computer and Information Sciences

Title of the study: Reducing Sedentary Behaviour in a Health Promoting University using Personalised Activity Notifications: An Application of the Integrate, Design, Assess and Share (IDEAS) Framework for UX Design.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, without providing a reason and without any consequences.
- · I understand that I will remain anonymous in the study.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me will be made publicly available.
- This study is being conducted by Carolina Wani, currently a student on the MSc in Digital Health Systems at the University of Strathclyde. If you have any questions about the study, please do not hesitate to contact me via my details provided in the information sheet.

I consent to being a participant in the study.

Participant's Name (PLEASE PRINT IN CAPITALS):	
Participant's signature:	
Date:	

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Participant Information Sheet

Name of department: Department of Computer & Information Sciences

Title of the study: Reducing Sedentary Behaviour in a Health Promoting University using Personalised Activity Notifications: An Application of the Integrate, Design, Assess and Share (IDEAS) Framework for UX Design.

Introduction

Sedentary behaviour (SB) affects the health of individuals, and without intervention, can lead to increased risks of cardiovascular diseases, type II diabetes, metabolic syndromes and cancers. While several anti-sedentary apps exist, an important challenge for designers of digital SB interventions is how often to remind or notify users to engage with a health app without becoming disruptive or annoying. A suitable solution might be the utilization of personalised activity notifications, grounded in behaviour change theories. This research aims to design and build a high fidelity prototype app that monitors a user's inactivity and empirically explores how and when to notify the user that an action is required.

The study is conducted by **Carolina Wani**, currently a student on the MSc in Digital Health Systems at the University of Strathclyde. If you have any questions about the study, please do not hesitate to contact me via my details provided at the end of this document.

What is the purpose of this investigation?

This research aims to design and build a high fidelity prototype app that monitors a users' sedentary behaviour/inactivity and empirically explores how and when to notify the user that an action is required.

Do you have to take part?

No, you do not have to take part. Participation is completely voluntary. You may withdraw from this study without giving a reason. The study will be conducted via an interview and two prototype evaluations. The data of each participant will be completely anonymous and confidential; no personal information will be collected and there will be no way to identify your individual information.

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Appendix 3: Interview Schedule/Topic Guide

Part One	Opening the Interview
Introduction	Thank you for taking the time to speak with me today. I am Carolina Wani, currently and MSc student at the University of Strathclyde. My research aims to design and build a high fidelity prototype app that addresses sedentary behaviour in university settings. The app design will include monitoring a user's inactivity and an exploration of how and when to notify the user that an action is required. The interview is split into four parts – a little about you, sedentary behaviour, personalised notifications, app design. You can interrupt and ask questions at any time and will also have an opportunity at the end to speak about anything you feel we haven't covered in this interview.
Timing and recording	The interview should take approximately 15-20 minutes. If I'm moving too fast, please let me know. I will be taping the session to capture all your comments. I will also be taking notes during the session. Please speak loudly and clearly so I do not miss your comments.
Confidentiality	All responses will be kept confidential. This means that only I will know the source of the data, and will ensure that information included in the report or viewed by my senior supervisor does not identify any respondents. Please remember that you do not have to speak about anything you don't wish to, and that you can end the interview at any time.
Information sheet and consent form (Check the recorder)	Please confirm that you have read and understood the information sheet and signed the consent form. Do you have any questions before we begin?
Part Two	Participant Background
Student or staff member?	I'd like to start by getting some basic demographics about you: Are you a student or staff member?

Hours in university	
setting?	On average, how many hours do you spend at a desk at university or doing
	university work away from university per week?
Engagement with physical	
activities	On average, how often do you participate in physical activities per week?
Age bracket?	What age bracket are you?
	18-24 / 25-34/ 35-44/ 45-54/ 55-64/ 64+ - Prefer not to say
Gender?	Male – Female – Other – Prefer not to say
(Check the recorder)	
Part Three	Sedentary Behaviour
To gain information on	I'd like to talk about factors in your desk time at university or doing
what participants know	university work that relates to sedentary behaviour.
about sedentary	
behaviour	Do you consider it important to move often?
	Tell me about how you decide it is time to move?
To gain information on	Thinking about the times you've spent long periods sitting at a desk in a
the participant's potential	university environment, are there any factors that make it easier or harder
sedentary behaviour at	for you to be sedentary?
university and at home.	
	Are you aware of any interventions the university actively does to increase
	your sedentary behaviour awareness? (Prompt: resources (i.e. persons,
Find out if the participants	campus services, organizations, policies) that provide information to
use any sedentary	participate in anti-sedentary related events?)
behaviour apps	
	Are you aware of any sedentary behaviour management applications?
Find out the participants'	
perceived usefulness of	
such apps at university	How do you feel about sedentary behaviour apps in terms of consciously
	addressing sedentary behaviour?
(Check the recorder)	
· · · · · /	

	Now, thinking about your working or studying environment at university or	
	on university related activities, are there factors that make it easier or	
	harder to address sedentary with an app?	
Part Four	Notification Behaviour	
Participant interactions	Thinking about the current apps you have on your phone, do you receive	
with current app	regular notifications from them? Can you give me a general idea of the types	
notifications on their	of notifications you have on your phone?	
smartphone		
	How often would you like to receive a daily message in the future?	
	Which ones make you respond by opening or reading them promptly?	
	(Prompt: Which features make you respond?)	
	Are there times when you ignore notifications from apps? Why?	
	Do you utilise any health apps?	
How the participants feel		
about personalised	How do you feel about personalised notifications on apps?	
notifications on apps.		
	What motivates you to respond to personalised notifications?	
	(Prompt: Would you think it was the notification itself, its style or the app's	
	information that makes you respond?)	
What the participants feel		
are the positives of	What do you feel are the positives – if any - of engaging with personalised	
engaging with	notifications (Prompt: notification behaviours e.g. how regularly they are	
personalised	received, read, actions taken, content-related etc.)	
notifications.		
	What do you feel are the negatives – if any - of engaging with personalised	
What the participants feel	notifications (Prompt: notification behaviours e.g. ignoring notifications,	
are the negatives of	excessive, annoying, disruptive etc.)	
engaging with		
personalised	Thinking of the time you spend at a desk, and your environment are there	
notifications.	any factors that would obstruct or restrict you from responding to	
	instructions to move? (Prompt: at work, office environments, labs, meetings,	
	lectures)	

	Are there any barriers or facilitators?
(Check the recorder)	
Part Five	Key Features for a Potential Anti-Sedentary App
To gain insight on participants' app design	I'd like to finally move on to discuss what design features you feel might encourage you to engage with an anti-sedentary app? (Prompt: interface design, colours, links to NHS information, community/social links)
What notification	What kind of messages or notifications would help motivate you to reduce or control sedentary periods? (Prompt or probe: notification styles e.g. LED flash lights, vibrations, customised sounds, visually attractive, discrete etc.)
features and/or	
requirements they	Are there any other functions that you feel the application should have to
perceive as potentially	keep you motivated? (Prompt: goal setting, gamification, diaries, charts,
useful should an anti-	pedometers, monitors)
sedentary app was to be	
developed	
M/hat functions could	
what functions could	
motivated to use the app?	
(Check the recorder)	
Part Six	Closing Interview
Thank the participant	Thank you very much for your time.
Any questions?	Is there anything you'd like to add that we did not cover in the interview?
Remind participants of	I will be developing a low and high-fidelity prototype following this, and
phase 2 (low-fidelity) and	would like to invite you comment on them closer to the time.
phase 3 (high-fidelity)	
evaluations	Please not there is no obligation to partake in these evaluations.

To explore the use of SB apps among student populations and ascertain the barriers and/or facilitators of students using apps for monitoring sedentary behaviour, particularly the context of personalised activity notifications.

1. Prompts: Things you may need to remind the interviewee about.

2. Probes: Getting the interviewee to say more about a particular topic.

Would you elaborate on that?

Could you say some more about that?

Appendix A: Example Transcript with participant 1.

P1.MP3

Participant 1 (P1) [00:00:21] Hello.

CW.P1 [00:00:25] Hello. Can I speak with [****] please? How are you?

Participant 1 (P1) [00:00:28] Hi Caroline. Yes I'm fine thank you. How are you?

CW.P1 [00:00:32] Not bad. Thank you very much for supporting me through this work.

Participant 1 (P1) [00:00:40] No problem it's a pleasure actually.

CW.P1 [00:00:42] Thank you. We'll jump straight into it I don't know how much time you have but it shouldn't take us more than 15 or 20 minutes just depending on how the questions and answers go.

Participant 1 (P1) [00:00:53] Yeah no problem. Yeah. So I mean obviously just on that consent I mean I'm obviously I'm more than happy just to provide the like the verbal consent they're like they're able to say that I've obviously read and understood the documentation and happy to proceed.

CW.P1 [00:01:09] Oh that's fantastic. Thank you very much. So we'll probably talk on that before we start the interview so I have a little bit of a script to get through to make sure everything's done correctly. Yeah okay. All right let's go. So thank you for taking the time to speak with me today. I am Carolina Wani as you know currently an MSc student at the University of Strathclyde. Overall my research is concerned with sedentary behaviour in university settings and aims to explore this via a smartphone app and personalised notifications. Now the interview will be split into four parts. Okay so it would be a little bit about you a bit about sedentary behaviour some parts on personalised notifications and then a little bit on the app design. Now you can interrupt and ask questions at any time and you'll also have an opportunity at the end to ask anything you feel that we haven't covered in the interview okay. Yes good. Okay. So the interview should take approximately 15 to 20 minutes. As I said if I'm moving too fast because I'm a really fast speaker please let me know. I'll be taping the sessions to capture all your comments so speak loudly and clearly so that I don't miss any of your of your comments.

Participant 1 (P1) [00:02:17] No problem.

CW.P1 [00:02:18] Okay good. All the responses are gonna be kept confidential. This means that only I'll know the source of the data and will ensure that information collected in this interview if viewed by my supervisor does not identify any respondents. Now please remember you don't have to speak about anything you don't wish to. You can end the interview at any time without a reason. So at this point please confirm that you've read and understood the information sheet and signed the consent form or in your case given a verbal consent.

Participant 1 (P1) [00:02:47] Yes I'm happy to read and understand really what's going on. And I'm more than happy to provide the verbal consent to proceed.

CW.P1 [00:02:58] Thank you. I'd like to start by just getting some basic demographics about you. Are you a staff or student member at the university?

Participant 1 (P1) [00:03:08] Student.

CW.P1 [00:03:08] Okay. So on average how many hours do you think you spend on a desk at university or away from university at a desk doing university work, on average work per week?

Participant 1 (P1) [00:03:33] So I mean one at the minimum, so this would be at the minimum an hour to three hours a day and you know probably pretty fair over there over this period. And you know during assignments and stuff you know you at least one hour to three hours a day.

CW.P1 [00:03:59] Okay. Thank you for that. Do you participate in any physical activities? If so, on average how many hours would you say per week?

Participant 1 (P1) [00:04:10] So yes I do. Do you participate eh the hours? So I mean obviously I cycle to my work and then I go to the gym. And then a go swimming probably say around about an hour and a half a day or so go over the course a week. Yep.

CW.P1 [00:04:37] Right. What age bracket are you? Between 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 64 plus. Or do you prefer not to say?

Participant 1 (P1) [00:04:52] No. It's 35-44 was it?

CW.P1 [00:04:56] Yes. And your gender? Male female other prefer not to say?

Participant 1 (P1) [00:05:03] Male.

CW.P1 [00:05:04] Thank you. And your ethnicity? How would you identify your ethnic background?

Participant 1 (P1) [00:05:09] A white Scottish.

CW.P1 [00:05:12] Thank you. So now we're going to go on to speak a little bit about sedentary behaviour. I'd just like to ask you about factors in your desk time at university or away from university doing work that relates to sedentary behaviour. So just to begin. Do you consider it important to move often?

Participant 1 (P1) [00:05:32] Yes. Yes.

CW.P1 [00:05:34] Why?

Participant 1 (P1) [00:05:38] To take it's more to do with my eyes. I always consciously think of my eyes I get my eyes a break but I know it's good to stand up and especially give your mouse arm a rest.

CW.P1 [00:05:56] OK. So it's more about the equipment and your eyes, it's more about screen time for you?

Participant 1 (P1) [00:06:05] Yes it is. It's definitely screen time. And I'm not I'm not really aware sort of my back or that but I am consciously aware of my right arm, my mouse arm really.

CW.P1 [00:06:19] Yes, you're trying to prevent repetitive strain injury?

Participant 1 (P1) [00:06:22] Yes. Yes.

CW.P1 [00:06:24] So can you tell me about how you decide it's time to move?

Participant 1 (P1) [00:06:28] Er Sometimes it's just actually just when I feel like it but I actually also use Pomodoro technique.

CW.P1 [00:06:42] OK. What's that?

Participant 1 (P1) [00:06:46] And so that Pomodoro is obviously a tomato in Italian and what it does is it's a wee working that you work in 25 minute bursts.

CW.P1 [00:06:59] Okay.

Participant 1 (P1) [00:07:00] I know it sounds like you do you know when I'm doing student work and personal work, so I'm obviously quite distracted so I know that actually if I can set the timer for 25 minutes and do a good 25 minutes work.

CW.P1 [00:07:18] Yes.

Participant 1 (P1) [00:07:19] I then set the timer for five minutes. Where I can go and have a break and a coffee or whatever. And then I try and do a sort of a short 25 minute bursts. There's apps and timers and everything that you could get for that. I've used that method for years.

CW.P1 [00:07:38] So that's an app on your phone?

Participant 1 (P1) [00:07:41] Yeah. Well it's an app on my computer but you can get on your phone or just like a desktop or so that you might try. So the decision is usually when the wee alarm goes off.

CW.P1 [00:07:54] I see. So thinking about the times that you spent long periods of time again sitting at a desk at a university environment or away still doing university work. Are there any factors that make it easier or harder for you to be sedentary?

Participant 1 (P1) [00:08:16] Sorry could you repeat that question.

CW.P1 [00:08:17] Yes sure.

CW.P1 [00:08:18] So just thinking about the times when you've spent long periods of times for example at a desk a university environment or when you're at home doing university work are there factors in your environment that make it easier or harder for you to be sedentary? Now I know one thing that you mentioned earlier is this app that you use but aside from the app is there anything that makes it easier for you to be sedentary?

Participant 1 (P1) [00:08:48] I mean a so in the library. I think that even in the small boxes, the amount of distraction, it actually you know leads me to actually get up and move. You know like I feel that you know I can sort of sit and do you know taking away the timer.

CW.P1 [00:09:17] Yes.

Participant 1 (P1) [00:09:17] To do so a good long work its only really bitty type work that I could do so I definitely place I like the environment so like the library it would be easier for me to get up and move about because actually I don't feel that comfortable in it

CW.P1 [00:09:41] You haven't reached the level of concentration to zone in?

Participant 1 (P1) [00:09:46] Aha. Whereas in my house doing university work err I could actually, taking away the timer, you know you can be sitting for an hour, and hour and twenty thirty minutes and then go oh my goodness you know I need to get up or something. So for me it's definitely more to do with the environment than the level of distraction.

CW.P1 [00:10:06] Okay great. I'm just speaking about the university environment that you've spoken about especially in the library the times that you've spent on campus. Are you aware of anything that Strathclyde University has done to increase your sedentary behaviour awareness? Or any information to participate in any anti-sedentary events?

Participant 1 (P1) [00:10:31] I mean I know that like we promote cycling but I don't know if that would be like more promoting like a transport mode rather than actually sedentary behaviour. So I think the answer to that question is no I don't know anything that the university has done to reduce sedentary behaviour.

CW.P1 [00:10:52] Okay. Now you spoke obviously earlier about using this app to break up your sedentary or work time, how do you feel about sedentary behaviour apps in general in terms of consciously addressing sedentary behaviour?

Participant 1 (P1) [00:11:10] Yes I do try and consciously manage it. I'm aware of the actually the physical impacts of it that but actually like their psychological and their like the efficiency or mental efficiency or I say like getting away from your desk can actually you know maybe help you frame the sentence that you were trying to write but also stop like back pain as well.

CW.P1 [00:11:45] So obviously you spoke earlier about this app that you use which may not necessarily be for sedentary behaviour but can you imagine using something like that at uni? Would it be as useful I mean that was at a desk app, but in terms of a smartphone app would that would something like that be useful?

Participant 1 (P1) [00:12:04] Yes for me.

CW.P1 [00:12:06] How so?

Participant 1 (P1) [00:12:18] Oh yeah. If it was a smartphone app with a widget add-on so it could sit on your home screen or your lock screen that would be in there.

CW.P1 [00:12:33] I see. So the ease of having it there would make it more straightforward more easily accessible?

Participant 1 (P1) [00:12:41] Yes.

CW.P1 [00:12:41] Okay thank you. And so we're just going to move on to a bit about your notification behaviour. Thinking about the current apps that you have on your smartphone do you receive regular notifications from them?

Participant 1 (P1) [00:12:58] So I switch all my notifications off.

CW.P1 [00:13:04] That's interesting. Why do you do that?

Participant 1 (P1) [00:13:07] Because I see that, I don't know maybe I'll explain it in two parts. When you go in to my home page on my phone and you see Twitter and Facebook I'll still see two or three or you know the wee red circles to show how many messages but I switch of all notifications to my lock screen so I don't I don't get any verbal or a physical notifications that say I've got a new message or a missed call or a new tweet or something as well so. Yeah.

CW.P1 [00:13:58] Okay. So when you do get the messages that you've seen obviously you know the little red circles, which ones make you respond by opening or reading them promptly?

Participant 1 (P1) [00:14:13] But I suppose it's the apps that I like the best.

CW.P1 [00:14:17] Yes.

Participant 1 (P1) [00:14:19] And the ones that's on my, so obviously on my phone I've got my home page which has got your Facebook or my Twitter, my BBC radio and then on page two or three is the apps that you know Snapchat the ones that I maybe use less so they'll be so there'll be sometimes where actually I might have notifications but because it's on the third page I maybe don't see it or don't bother checking it for maybe a day or some couple a few days for example.

CW.P1 [00:14:53] Okay so these are then the times when you ignore the notifications. So would you say it was because of the level of interaction you have with that app?

Participant 1 (P1) [00:15:16] It's just not important. And I suppose you know I know what I know what app my family and family friends usually contact me.

CW.P1 [00:15:32] Yeah.

Participant 1 (P1) [00:15:33] And so you know that app whatever it is has higher value and everything else is sort a like fun if you know what I mean?

CW.P1 [00:15:43] For sure. Let's move on, how do you feel about health apps in general?

Participant 1 (P1) [00:16:02] Erm. I'm agnostic to be honest I mean in some I could see that actually it's a game, but I do appreciate that that game can have a you know say you know physiological psychological motivation to help you stay fit. Actually I actually don't use any but you know I could pick up one tomorrow and like it I'm just kind of agnostic on them.

CW.P1 [00:16:35] How would you feel about personalised notifications? I know you mentioned that you have a family app. Are the notifications on that personalised?

Participant 1 (P1) [00:16:48] No. No. No. Basically it's just that it's just the generic out the box one that you would get. So. So it's either you know my family would contact me using the SMS so the phone app or WhatsApp so you know the notifications are just standard or generic ones.

CW.P1 [00:17:12] Okay. So just generally then how would you feel about personalised notification on apps?

Participant 1 (P1) [00:17:21] I mean. I mean if they you know if the app was something that I could see value in for me then yeah I mean it would be fine.

CW.P1 [00:17:33] Yes. Just speaking again just on the personalised notifications aspect, what you feel might be the positives if any of engaging with such apps?

Participant 1 (P1) [00:17:55] Well you know I think they're. I mean I think if you could personalise your location and configure it, so i.e... You know you could say you know you know I'm only bother me you know or you know at a 30 minute period. And only do it by light or haptic feedback or you know send me a text you know like that sort of thing. Actually I could personally configured it in the way I want then actually I would see more value in it. And I'd be more likely to use it if you know what I mean?

CW.P1 [00:18:44] Okay. Just the opposite side of that do you feel that there may be any negatives with engaging with personalised notifications?

Participant 1 (P1) [00:18:57] Yes. I've got, there's an app I've got called Thrive. What it does is it's a timer. And it sort of switches off all notifications and all calls. And so I don't receive any calls from my work I can configure and see something like I only want calls from my mum and my wife. All other calls will be sent straight to answering machine by this app. This is [****] is busy just know and will get back to you. That the notification to remind me to use that app is the worst thing I absolutely hate it.

CW.P1 [00:19:45] What is it about it that makes you dislike it?

Participant 1 (P1) [00:19:49] And so I love the app, but hate the, see if it's not been used in a like a day or two, what it does is it vibrates. It doesn't make a noise right. But it vibrates normally I can describe it as vrrrm. And it just keeps going. And it's obviously designed to go 'I'm here, use me' but

actually it actually puts me off the app. If I could configure how that notifies me to prompt me, oh by the way to go oh me you know you know, use this. It would definitely be better.

CW.P1 [00:20:33] Well. I'd like to know a bit more about that myself actually.

Participant 1 (P1) [00:20:38] Yeah I'll share the link.

CW.P1 [00:20:40] Thank you. Let's move on to finally discuss about the design features you might feel would encourage you to engage with an anti-sedentary app. So if you're unsure just think about the key design features that you've enjoyed in other apps.

Participant 1 (P1) [00:21:04] Well, a simple login that I could use my G-mail account my Google account with. So it links to my Google account so I don't need to even any username or password or anything. Or if it's to do with university it uses my university single sign on page so automatically it just prompts me to click ok, that would be good.

CW.P1 [00:21:46] And that is really good for ease of interaction?

Participant 1 (P1) [00:21:50] Yeah. Well ease of signing up. You know that sort of how I get on board. It is you know that's what I really like. I think it's I think it's really good use of technology to simplify the on boarding process.

CW.P1 [00:22:11] That's fantastic. How do you feel about links to NHS Information or community groups or social links?

Participant 1 (P1) [00:22:33] The way that you've described it actually it's to do with helping me you know. You know reduce the impact of sedentary behaviour on my body.

CW.P1 [00:22:54] Sure

Participant 1 (P1) [00:22:57] I don't know, I could maybe see the health information. So we can all you know repetitive strain injury, back injury you know things to do stretch and that kind of thing here. But with regards to like a local event or you know walks this stuff I'm not too sure about that.

CW.P1 [00:23:20] Thank you for that. So just thinking still about this design aspect of the app. And just you spoke earlier about that app vibration that goes on forever and it can be slightly annoying. What sort of notifications do you think would help you for example if it was going off every half an hour during the times that you were being sedentary?

Participant 1 (P1) [00:23:47] So if I had my phone and a smart watch.

CW.P1 [00:23:54] Yes.

Participant 1 (P1) [00:23:54] Then obviously you know like a short maybe three blip buzz, you know something that's short but you know it's obviously it's a balance between obviously letting me know that something's happening but actually or prompting me to do something and then not sort of bothering me to the point of frustration. So I don't really use any light notifications, I switch of all light notifications straightaway that's what I've always done on all phones for years. I just I've never use them. So either the haptic the vibration or sound would be fine.

CW.P1 [00:25:07] Would be the most appropriate. Can I just ask him why you don't use the LED flashlights?

Participant 1 (P1) [00:25:18] Well it's sort of like you get blue flashing lights white flashing lights red flashing and I just I just can't be bothered learning what all the different flash lights mean. I didn't need to learn that, I cannot be bothered. Whereas actually that the buzz is almost that I don't even need to think, it's just there buzz like ok something's happened. Check my phone you know.

CW.P1 [00:25:54] That's great. So earlier you mentioned something about gamification on an app. How do you feel that functions like that might support an anti-sedentary app? Gamification, goal setting diaries, charts, pedometers, monitors these sorts of functions.

Participant 1 (P1) [00:26:19] Yeah. I think that would be, for me anyway. That would be you know. You know really good. I think it's about that setting when you first go in about setting your own goals about what you want to do. You know, like in general and so maybe when I go and sit at a desk I just switch the app on and then I'm already I already kind of know that in 30 minutes I'm gonna get that, same as the other app, Thrive what happens is that it goes to the end and then goes 'OK. What did you do in that 30 minutes? Was a useful?' What that means is actually you can create like a dashboard and so it's like 'Oh well done you've done 100 minutes of focused work'.

CW.P1 [00:27:20] Right. Well that's interesting. So do you do you feel like being monitored or going back to a chart is useful? Do you see anything useful either way?

Participant 1 (P1) [00:27:57] And well I actually see value in the two to be honest. Actually you know one of the values I think with the desktop app with a timer or a Pomodoro timer is that actually that's all it does it's just a timer. It's nicely laid out. It's simple it's clean. It does exactly what it says. It's not trying to be anything else and it's simplicity is its beauty. But also think that actually you know if I'm going to spend you know five years at university, a way that I could actually I could manage. You know I'm going to be a you know in first year I'm going to be spending a lot of time sitting and so actually I could see both of those two, I would be really happy either or.

CW.P1 [00:29:10] No that's fantastic. I mean there is value definitely in both sides. Having said that we have come to the end of the interview and thank you very much for your time. Is there anything else that you'd like to add?

Participant 1 (P1) [00:30:03] No. No I mean that. No. I think you know. It's you know that you know there's been obviously you've promoted many questions. No. I mean obviously just I'll share the couple of apps that I mentioned so you can see them as well, well for me I think that's fine.

CW.P1 [00:30:25] Okay. So I'll be going off now to develop a low and high fidelity prototype over the next two weeks or so and obviously like to invite you to comment on those closer to the time. But there is no obligation to take part in that. I'll just send you a brief email and asking you some questions or maybe if I could possibly have you look at a paper prototype or some other aspect of it but that will then be closer to the time.

Participant 1 (P1) [00:30:50] Yeah that's fine that's no problem at all happy to help any other stage of this.

CW.P1 [00:30:56] Thank you so very much.

Appendix 4 – Lo fi feedback

Low Fidelity Evaluation/walkthroughs with Participants [2], [3], [9] and [10]. See Table [...] for participant demographics

Screen	Participant Feedback	Critical Design Changes Made
Screen 1	Self-explanatory, no issues	
Screen 2	Participants could easily locate the University of Strathclyde App	
Screen 3	Self-explanatory, no issues	
Screen 4	[P3] for me this app is a lot of things so I find it a bit busy. But I see it's a plus and you add stuff.	Participant referring to the business of the Uni's tile apps.
Image: state	Self-explanatory, no issues	
Image: Contract of the second seco	[P3] its quite simple, if I knew this app had Strath DESK! on it, it would be a case of, I know I could easily add it and hide other stuff I don't want which is a bonus.	

Screen 7	[P2] easily able to add tile to app – the font is tiny font, the icons are small and not clear what, but that's to do with the Strathclyde platform in general	Concern with the Uni's icons.
Image: Control of the control of th	[P2] can find it easily – familiar institutional log in	
Hi Carolina Welcome to Strain DESKO Screen 9	 [P9] I like that it is plain, there's no noise [P3] its nice and clear, stuff like that's good, you're not just dropped in a menu, there's a bit of an introduction. [P2] - really clear, clear its part of the Strathclyde app because of the logo, hi and your name is clear and personalised. No sure why there is an hourglass, I did notice it here, not sure what that represents [P10] I would wait at this page, I would expect it to load itself. 	Explained to [P2] what the logo was about (measuring wellness and not time), after which she liked it. No changes Explained to [P10] how the page works, the logo was similar to her Mac, which indicated it was waiting to load.
Screen 10	 [P9] I can understand this because I use a lap top at home. I think the 'Link to my timetable' is opening up Pegasus? It's good because it integrates information from other university systems, that you'd have to log out of one and go into another. [P3] oh yes so this is good, on 'Link to my timetable' I like that because it saves the need to go on myself and add this that and that, it's smart enough to go 'based what you have on this timetable you should probably have these breaks in between'. [P2] I like the hourglass is a reference back to the home page, clearly you see its linked. It's clear what you mean my mode. 'link my' had I not seen the that, I would have thome screen, but I think it would 	

	bring up my timetable. Staff diary - that totally makes sense. If you had to manually put in it I think less people would do it – nicely laid out. [P10] does it link to smart watch	New feature added, link to smartwatch
Contract of the second	[P10] I would prefer the time first, it gives me a better option, here I would have to read all that to see the time, morning, afternoon and so on.	Participant was concerned about the order of the time, and agenda. Format changed
Screen 12	 [P9] Strath DESK! Insights? I don't know what that is. [P9] I like the design, I like the colour, I like that its white with the black text. I don't have any forms of dyslexia so it's comfortable for me to look at. It may be good if people could customise the colours. [P9] overall initial thoughts? Brilliant, I like it, it's very sleek, it's very personalise-able. I like the colours, they kind of go with the university theme. There's always a lot of blue with the university of Strathclydeit makes me feel that I know that its University of Strathclyde because it's the same recurring colour of blue. I like it's only one swipe to the next page, not having to go back. [P3] I know it's a menu icon, so it's pretty normal, looking at the hourglass, I know that's the icon for the app, but my brain wants to say timer. Insights, is that statistics? That makes sense, I'd probably look at that, would that be your own or would that be everyone using the app? [P2] little icon makes sense, Strathclyde related policy, consistent with Strath, reputable policy – totally what I thought, insights indicate data [P10] straightforward 	Explained the concept to the participant. Changes made in the layout. Pointed out accessibility. Need to make sure it is accessible to all. Participant became quite familiar with the logo and concept. Issue with how participants are interpreting the 'weekly insights' page. Changes made.

The second secon	[P3]oh yes that's the logo, it may need a little label to say what this does. If I knew, its consistent, if I knew they do the same thing, I'd be like oh that's the home button. Its nice when you get a nice name that's snappy and fits, simple summary [p2] dead clear	
Fire Processing and the second	 [P9] obviously I understand privacy policy is about sharing of data and GDPR and that. [P3] its always there and we never check it, it's probably the nicest one I've seen, it's nice and simple. I was thinking this was too easy, there's not jargon, no layers and layers of ins and outs. For me I'd probably want more details to read more into it. 	Participants easily understood the privacy policy Explained that the Strathclyde logo leads the user back to the main, more detailed privacy policy.
Screen 15	 [P3] so looking at this, this is my personal insights, it's a simple way of displaying it so it's not all crammed portrait. It's a nice clear layout, I'm looking at these percentages and these all add to 100% together, so is that 50% of my time spent there is sitting? I would like a little description, a way to be told this is what that is. Label for axis – 35% of what [P2] 50% – did I spenderm confusing, at a library desk, not entirely sure what that 50% represents –so it's your compliance and? 	Instructions added
	 [P2] Definity would follow the app. Colouring, I think the different colouring represents different places, whereas somebody else might see that and see 35% and see that its green and think that its good. Because green tends to be associated with positive, well done thumbs up whereas red is the opposite. Percentage is good, everyone could understand the percentage, it's better than a number, different people would have different percentages, visually appealing. Perhaps a dash to indicate if someone hadn't sat at their desk this week. 	Understood the different percentage colouring represented the different modes or locations in which the user is at i.e. library, lectures, labs, offices. Participant would have preferred the colour based (red, amber, green) system as an easier way of interpreting the personal insights Participant raised an issue with the stats if a user had not used a particular mode in a week and suggested perhaps in that case a dash inside the circle instead of a 0 percentage
desks? I should have understood	Important distinction made, more	
-------------------------------------	-------------------------------------	
that earlier. Percentages don't add	instructions added. Decided to test	
up to 100 percentnot obvious if it	the screen for more feedback	
was measuring time being sedentary		
or percentage of adherence?		

Appendix A: Low Fidelity Prototype Evaluation

Strath DESK! tasks for users to perform

Thank you for your participation. There are 2 tasks in total to perform on this low-fidelity version of the Strathclyde Design-Enhanced Sedentary Kit (Strath DESK!). Please say what comes to mind regarding your interaction with the system, including thoughts the interface design, colours, functions, what works well, what does not work well, what confusing and so on. Your hand movements and spoken thoughts will be recorded for the research purposes.

This is a <u>low-fidelity evaluation</u>. I (the researcher) will take on the role of the 'wizard' (think of the Wizard of Oz concept) which means that I will simulate changes in the screen, page by page. I may also ask you what you think about specific features in the design. Your hand movements and thoughts as you interact with them will be recorded;

Task 1: Find the Strath DESK! app and log in (pass security) – This test was intended to ease the participants into the app with some familiarity.

Task 2: Set your mode of reminders by linking to your timetable (as the core and most critical function of Strath DESK! this test was to gauge the participants' intuitiveness with the system).

Strath DESK! tasks for users to perform

Appendix A: High-Fidelity Prototype Evaluation

This is a high-fidelity evaluation. I will record your interaction with the Strath DESK! app on the screen. Please use the mouse to navigate all sections of the app and speak as you go through. Once familiar, please try tasks 3, 4, 5 and 6.

Task 4: Find the settings and select the sounds and notifications you'd prefer. (This task was to see how the participants dealt with personalising the system)

Task 5: Find the main Strath DESK! dashboard and manually set a reminder in 'Library DESK!' (This task was to see the dashboard's ease of use)

Task 6: When the Strath DESK! app notification alerts you, please accept it and proceed to move your position (This task was to observe if the participants could safely and correctly follow the prompts to move)