UNIVERSITY OF SOUTHAMPTON

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING

School of Electronics and Computer Science

On the Inclusion of Social Media Features in Digital Behaviour Change Interventions

by

Sheik Mohammad Roushdat Ally Elaheebocus

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ABSTRACT

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING
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Digital Behaviour Change Interventions are techniques for providing targeted advice and support for enabling sustainable and positive change in people through digital platforms. The possibility for conducting large scale interventions at low cost are becoming a reality while also offering increased flexibility in terms of time and location at which they can be undertaken. With the ubiquity of social media, there is a growing interest in tapping into the social influence prevalent among potential participants for enhancing the effectiveness of behavioural interventions. However, the lack of a consistent approach to incorporate social media features has resulted in only a limited number of interventions making use of them through non-standardised designs, making it difficult to compare the efficacy of social media features across studies. This thesis sets out the integration of social media features in a generic framework to demonstrate how intervention builders can identify, include and evaluate the most appropriate social media features into their behavioural interventions in a more standardised way. A systematic literature review was conducted to identity social media features that are commonly included in these interventions. This review, coupled with a thematic analysis of a focus group-based study composed of experienced intervention builders and a pilot experiment to test for usability and feasibility, led to the development of an annotated taxonomy of social media features for behavioural interventions. An experiment to evaluate the inclusion of generic social media features in a behavioural intervention, facilitated by the taxonomy and though our framework was performed. This research demonstrated the feasibility and potential of using generic social media features in behavioural interventions with standardised designs, which will facilitate future evaluations of the impact of these features within interventions.

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Research Thesis: Declaration of Authorship

Print name:	Sheik Mohammad Roushdat Ally Elaheebocus

Title of thesis:	On the inclusion of social media features in digital behaviour change interventions

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
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   Elaheebocus SMRA, Weal M, Morrison L, Yardley L. *Peer-Based Social Media Features in Behavior Change Interventions: Systematic Review*; J Med Internet Res 2018;20(2):e20

Signature:		Date:	

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And my parents who have always believed in me.

Chapter 1. Introduction

Inducing positive changes in people's behaviour is a widely explored and active area of research commonly referred to as Behaviour Change Intervention (BCI)[1]. With advances in Information and Communication Technologies, scientists have developed Digital Behaviour Change Interventions (DBCIs), defined as "……a product or service that uses computer technology to promote behaviour change" [2], in which platforms such as the Web, mobile applications or wearable devices are used to deliver interventions with lower cost overheads while offering numerous additional benefits to users. Smartphones, becoming more ubiquitous than ever have made it possible for interventions to be accessed from anywhere and at the most convenient time along with other possibilities such as nudges and notifications. Therefore, it is beneficial to port DBCIs to these devices as discussed in the work by Lathia et al. [3].

An example of a DBCI would be in a smoking cessation programme whereby participants would be using a mobile-phone application to read carefully vetted health information provided by experts in the area, get advice and tips about how to drop the habit, report on their addiction levels (e.g number of cigarettes smoked daily) and receive on-going support through the application for encouraging them to adopt a healthier lifestyle without smoking.

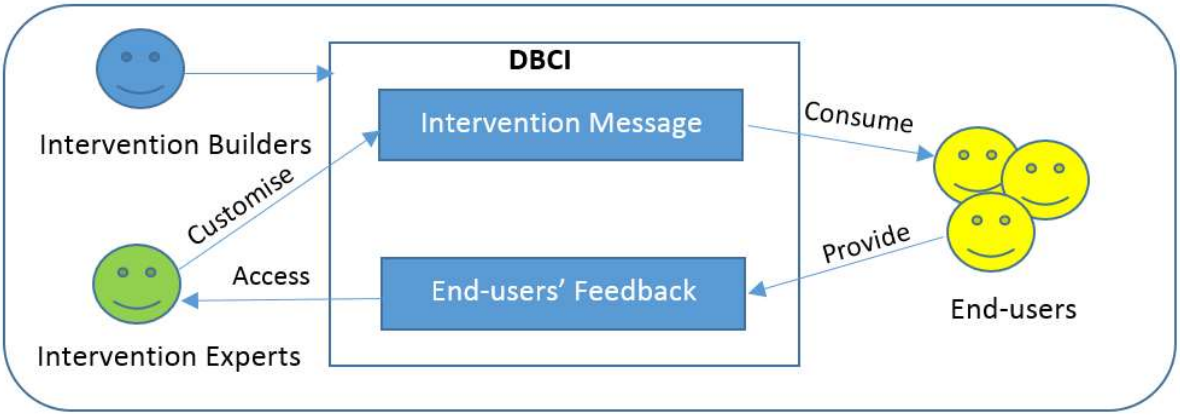


Figure 1. Actors in DBCIs

Based on the example described above, Figure 1. shows the different actors in DBCIs; Intervention builders are usually social scientists or healthcare professionals who design and build interventions which could include some intervention message (e.g. how health is affected by smoking). End-users are the participants in the intervention (e.g. the smokers who want to stop smoking). These end-users provide feedback (e.g. reporting the number of cigarettes smoked daily). Intervention experts or therapists are trained professionals in the area of that specific intervention (e.g nurses knowledgeable in the area of smoking cessation) who provide advice/support to end-users and customise the intervention's messages based on end-users'

feedback. It should be noted that not all interventions include experts or therapists for on-going support as this usually depends on their requirements.

Using technologies such as the Internet and sensor-rich phones could be a tremendous leap towards large-scale behaviour change interventions. However, we should realise that human beings are instinctively social creatures, living in communities. While current DBCIs using smartphones focus on gathering data through high-tech sensors, enormous amount of information that individuals share naturally among peers is left untapped; These include interactions on Online Social Networks (OSNs) such as Facebook, Twitter, Flickr, etc and through the use of Social Media Features (SMFs) such as online forums, polls, chatrooms, etc. In this thesis, an SMF is referred as a feature that enables its users to create and/or share content, communicate or interact socially on the Internet. These SMFs may provide new mechanisms to understand individuals and deliver DBCI content. This can in turn make it possible to better adapt interventions and deliver them. Another aspect that can benefit the outcome of such intervention is the social influence present on OSNs as identified by numerous research [4-7]. While existing research using SMFs in DBCIs have explored intervention-specific designs, no generic framework exists yet for incorporating SMFs into interventions. According to Fogg's behaviour model, a combination of three factors is necessary for a change in behaviour to occur; motivation, ability and trigger [8]. This research looks into how to facilitate the inclusion SMFs so that they can be leveraged to provide these factors in DBCIs. This will enable intervention builders to more easily select, adapt and evaluate the impact of including SMFs in their intervention.

Providing targeted advice and support for triggering a sustainable and positive change in behaviour is considered to be an important technique. This has been explored and put into practice by intervention builders who are usually social scientists or health professionals, to help individuals improve their health, quality of life or for some 'good' cause (e.g. Reducing pollution). When employed upon large targeted groups, whole communities may reap benefits. There has been numerous research dealing with behaviour change interventions (BCIs) although definitions of the techniques are still evolving and therefore difficult to replicate [9]. A common framework making use of the 5A's model (assess, advise, agree, assist, arrange follow-up) can be used for development and deployment of BCIs [10, 11].

BCIs have been used in a wide variety of situations ranging from chronic health issues such as Cardiac Patient Rehabilitation [12], Cancer Risk Minimisation [13] to more preventative but nevertheless important to everyday life habits such as physical activity, nutrition and obesity prevention [14-16] and smoking cessation [17].

While BCIs have been used for a long time, they are considered resource intensive and often costly. Interventions using Face-to-face tend to be personal but very resource intensive while those using traditional large-scale distribution such as leaflets, although less resource intensive, do not allow for much complexity or tailoring. Tailoring has been found to enhance the effectiveness of behaviour change interventions as reported by Lustria et al., [18] after analysing past print-based behaviour interventions. On the other hand, DBCIs have good scalability while allowing for better tailoring and more complex interventions.

1.1 Digital Behaviour Change Interventions (DBCIs)

According to a survey by McCully et al.,[19], there is an increasing viability for using the Internet as a platform for delivering BCIs on large-scale as more and more people are looking for help concerning their health and well-being issues. With the widespread and low-cost access to the Internet, BCIs are being adapted for online usage in what is referred to as Digital Behaviour Change Interventions (DBCIs). Using the Internet for delivering these interventions can address many of the drawbacks of the offline and conventional BCIs [20]. In addition to the personalisation and adaptation possibilities, cost-effectiveness of behavioural interventions, anonymity, confidentiality and accessibility are among other benefits. These are being successfully harnessed through a number of web-based interventions as described in the next sub-section. In order to provide further flexibility such as providing end-users with on-the-go access and easier self-monitoring capabilities, mobile-based interventions have been introduced [21].

While Web-based interventions offer the possibility of reaching large groups of individuals, making individuals aware of them is important. Crutzen et al.[22], proposed to tackle this issue by making use of online word of mouth for motivating individuals to visit online interventions.

Although the use of mobile phones for DBCIs is not new, the limited capabilities of such phones some years back meant that only basic features could be implemented for these systems such as the use of Short Message Service (SMS) as proposed by Fjeldso et al., [23] and in order to provide more interactivity, PDA-based applications were used in limited instances [24]. However, some degree of personalisation was already present through the use of personalised text-messages to end-users with one example being the Text2Quit study by Abroms et al. [25], which tracked the number of cigarettes smoked by the end-users and sent them tailored messages. With smartphones becoming more popular, DBCIs have also been developed in the form of mobile phone applications [26-28] to be closer to individuals but also to enhance customisation of the interventions through the use of contextual data provided by

sensors embedded in the phones. This merging of BCI applications with the sensing capabilities of smartphones has also been explored by Lathia et al., [3]. Lane and Mohammod [29] presented a personal health application for smartphones which used sensors such as the accelerometer, digital compass, GPS etc to monitor personal aspects of end-users including sleep, physical activity and well-being automatically. The application then provided customised feedback to each end-user. Another example for using smartphones' sensing capabilities was demonstrated by Pejovic and Musolesi [30] who created a mobile application to proactively tackle depression. It worked by monitoring end-users' movements, lack of socialising and irregular sleep patterns through a combination of sensors such as GPS, accelerometers as well as Bluetooth. Whenever signs of depression were detected, end-users were provided with an adapted intervention tool through the application; for example, a web link to buy theatre tickets for two persons whenever a lack of social contact was determined. However, much work remains to be done in this area since smartphones with advanced sensors are rather recent and their impact on the outcome of interventions is largely still being evaluated. As with most innovations, initial feedback from users gathered by Dennison et al., [31] showed some degree of reluctance and a feeling of embarrassment in cases where the end-users' engagement with such applications would be widely broadcasted. It is expected that with more and more end-users using such applications, it will eventually become socially acceptable due to peer influence. Also, by including some control mechanisms to empower end-users with the choice of what and when to share information about the applications, this may inspire more trust from them.

The pervasiveness of Internet access has meant that users can easily browse the Web through their smartphones. This has led several research studies to come up with a combined approach of delivering interventions to mobile devices which enable users to retrieve information from the web and publish online as well [28, 32]. With the evolution of the web, the role of social media in DBCIs, especially online social networks, has recently gained researchers' attention.

1.2 Social Media Features (SMFs) in DBCIs

By their inherent nature, websites were primarily designed as passive information publishing platforms. With its evolution into what is commonly referred to as Web 2.0, the traditional model of Web users being merely consumers have morphed into one of publisher/consumer paradigm usually termed as Social Media. One of the most popular web services promoting this concept is online social networking. As active participation is a key aspect of the success of behaviour change interventions, Online Social Networks may be considered as a potentially useful platform for enabling effective and sustainable positive behaviour change along with the

enhancement of user engagement since they are known to require their users to actively engage and generate content [33].

Social Media platforms enabling social networks to form online have greatly modified the communication and interaction patterns of individuals [34]. The different services offer a variety of tools, methods and medium for interaction among members along with capabilities for controlling one's privacy at varying levels.

Using SMFs as part of DBCIs is a new area of research as evidenced by Maher et al., [35] extensive review of publications about "Health Behaviour Change Interventions That Use Online Social Networks" in which only ten research studies were identified as fitting their selection criteria which was rather flexible as the review included studies targeting participants from any age groups and used existing OSN platforms or purpose-built ones. However, they had to target at least one out of four general conditions identified by the World Health Organisation as leading risk factors for global disease burden which included tobacco smoking, alcohol use, physical inactivity and diet. This could have been a bit restrictive and narrowing down the list of potential review candidates. Furthermore, most of the reviewed studies consisted of interventions which were designed for a particular context and therefore, could not be easily re-used.

1.2.1 Benefits of SMFs in DBCIs

Although research focussed on the use of SMFs in DBCIs has been gaining more popularity only recently, at least two benefits from end-users' perspective are commonly mentioned in the literature. These are social support which is based on the social influence factor prevalent with the use of SMFs [4, 5] and an increased user engagement in behavioural interventions [36].

However, since most of the studies reporting similar benefits addressed weight-loss, dieting and physical activities, it is difficult to contextualise them. Indeed, it seems likely that benefits derived from the use of SMFs in behavioural interventions will vary based on the nature or condition being addressed by the intervention, the end-users' demographic profiles, duration of the intervention and other similar factors.

A perceived benefit of using SMFs in behavioural intervention could be an enhanced level of interactivity and communication among end-users which could be co-related with user-engagement. End-users are able to interact and communicate with other end-users as well as existing friends and contacts through the SMFs provided. Intervention experts can also interact with the end-users such as the nurse-patient model implemented in the LifeGuide project [37] which provides intervention builders with a web-based platform for creating behavioural interventions enabling nurses to support their respective 'patients'.

Since many users of social media, specially OSNs, are 'always' online, they can be sent timely messages or notifications. Making suggestions at the right time may increase the likelihood that the targeted audience will act upon them due to the compelling and timely characteristics of the messages presented. This has been discussed as the Kairos principle by Greek orators who stated that it is also possible to recognise or even create favourable occasions based on practical guidelines [38]. According to Fogg [39], delivering important messages at opportune moments is more influential in the sense that it takes advantage of people's existing aspirations to make these messages persuasive.

It is also expected that the use of some SMFs might enable a wider dissemination of the interventions as more people will get to know about them should end-users share data on popular OSN platforms such as Facebook; Potentially providing an opportunity for recruiting a large bank of volunteers through snowball sampling. For targeted interventions, people will be able to refer their friends and contacts who they believe are in need of the support provided by a specific intervention. On the other hand, social platforms can be used to broadcast information and links to interventions which are more generalist in nature.

Due to the wide variety of conditions that can be addressed through DBCIs, currently, there is no compiled and structured description SMFs along with their effectiveness in different situations. Therefore, this thesis also looks into this aspect and provides some enlightenment about the benefits of SMFs to end-users in different contexts along with a taxonomy of SMFs for behavioural interventions.

1.3 Problem Statement

Currently, there is no generic framework that can enable intervention builders to design, develop and deploy DBCIs which facilitates the inclusion of SMFs. Such a framework could define the appropriate re-usable structures for building different SMF-enhanced DBCIs targeting a wide variety of conditions in flexible ways. While the UBhave project [3] was being developed to bridge the gap between Web-based interventions and sensor-rich smartphones, there is a potential to further enhance the framework through the integration of SMFs which can also introduce interaction capabilities among end-users as well as between end-users and experts delivering the interventions. Care should be taken to facilitate its usage without the need for complex technical support to intervention builders. This requires designing appropriate models for the interventions along with the development of authoring tools for creating the interventions and data analysis tools to help interpret end-users' data. Eventually, intervention builders will be empowered to easily disseminate their interventions to the mass online population while also, enhancing their ability to gain access to interventions' data. One

drawback of existing interventions using SMFs, as mentioned earlier, is their specificity; therefore, with SMFs integrated into a generic framework, it is anticipated that they should be adaptive to various contexts such as the type of intervention, category of targeted end-users and nature of data. Developing interventions through this framework will facilitate evaluation across different interventions as these will be structured in more standardised ways.

Since the framework is expected to be re-used by the academic and scientific community, there is a strong need for it to be open-access in order to encourage a maximum of researchers to further extend it in the future.

1.4 Research Hypothesis & Questions

The current research examines the following hypothesis:

Social Media Features can score high in terms of usability and can provide a number of benefits to end-users when integrated in behavioural interventions through a generic framework.

In addressing the hypothesis, the following five key research questions have been identified:

1 Do behavioural interventions that integrate SMFs have positive effects on end-users?

2 What are the expectations of intervention builders with respect to the inclusion of SMFs in behavioural interventions?

3 How can SMFs be organised so as to standardise, facilitate and guide their inclusion in behavioural interventions?

4 How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?

5 Do end-users perceive SMFs as useful and user-friendly components within interventions?

Question one explores the different social media features that are commonly included in behavioural interventions and reported in the literature. Identifying SMFs that have already been used in behavioural interventions is an important step towards addressing the hypothesis of this research. This also enables us to identify patterns of SMFs' inclusion to address different behaviours along with their impact on end-users. Likewise, the extent to which these SMFs have an impact on the overall outcomes of interventions is analysed.

Question two's emphasis is on gaining a good understanding about the intervention builders' expectations and perception with regards to the usefulness and anticipated benefits for including SMFs in behavioural interventions through a generic framework.

Question three addresses the issue of structuring SMFs in an appropriate way so that intervention builders can easily identify SMFs that are most suitable for their respective

context. Using SMFs in a standardise way will also facilitate comparison between studies and help isolate their different effects in behavioural interventions.

Question four focuses on the issue of intervention builders making use of off-the-shelf or one-off tailor-made solutions for their interventions. This in itself can create multiple issues such as financial cost, flexibility to customise, and possibly computer programming skills requirements for example. Therefore, this question covers the finding of techniques to facilitate the integration of SMFs into behavioural intervention by intervention builders who may not be versed in computer programming and also enable them to easily customise these SMFs to their requirements. Subsequently, if SMFs are made more accessible to intervention builders, this may help to establish a stronger evidence base for their usage.

Question five helps determine whether end-users find SMFs that have been included and customised through a generic framework as easy to use and useful. These aspects may impact on their usage and the subsequent intervention outcomes. Demonstrating their ease-of-use and usefulness to end-users can reinforce their inclusion in future behavioural interventions through our proposed techniques.

1.5 Research Framework

Creating the right environment for intervention builders to easily integrate SMFs into their interventions while ensuring that these features benefit end-users, is the main goal of the research presented in this thesis. Based on the hypothesis described in the current chapter along with the five key research questions formulated for its subsequent validation, the thesis has been organised into eight chapters.

In the current chapter, Chapter 1., there has been a discussion about the lack of a generic framework for facilitating the inclusion of SMFs in DBCIs and the difficulty in conducting cross-studies evaluation of these features. In order to gain a better understanding of how SMFs are used in DBCIs and their reported impact on participants or the interventions themselves, a Systematic Literature Review (SLR) has thus been undertaken and presented in Chapter 2. The review helps in addressing the first research question "*Do behavioural interventions that integrate SMFs have positive effects on end-users?".* Based on the review's findings, a set of objectives that helps in orienting the research has been formulated.

Gaining a better understanding of the motivations and expectations of intervention builders with respect to the inclusion of SMFs in DBCIs has been one of the objectives put forth in Chapter 2. This is tackled in Chapter 3. in the form of a focus group study in which experienced intervention builders participated. Its subsequent analysis enabled us to address the second

research question: "*What are the expectations of intervention builders with respect to the inclusion of SMFs in behavioural interventions?".* The analysis also revealed that the two most appealing SMFs to the intervention builders were polls and a Socially-enhanced knowledge repositories (forums). One of these two features, the poll, has been used as part of a pilot experiment (See Chapter 5.) and both features are used in a subsequent, final experiment (See Chapter 6.) The taxonomy of SMFs (See Chapter 4.) whose development started alongside the systematic review also benefitted from refinements based on the results of the thematic analysis of the focus group study.

One of the research questions in Chapter 1., "*How can SMFs be organised so as to standardise, facilitate and guide their inclusion in behavioural interventions?",* in the context of the lack of standardisation in the use of SMFs in DBCIs as confirmed during the systematic review is addressed in Chapter 4. where the development of a taxonomy of SMFs is presented.

Chapter 5. reports on a pilot experiment aimed at determining the feasibility of using a generic framework for creating DBCIs which incorporates SMFs. The lack of such a framework is discussed in the first two chapters of this thesis. The outcome of the pilot experiment led to the design of a final experiment in Chapter 6. which makes use of a generic framework that also includes an intervention authoring tool for facilitating the inclusion of SMFs in DBCIs to address the research question "*How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?"*. Their evaluation is presented in Chapter 7. Based on an existing DBCI has been extended for the purpose of this experiment to incorporate customised SMFs using the authoring tool. The research is concluded in Chapter 8. with an overview of the different contributions made through the different chapters of this thesis along with a set of recommendations and future work.

1.6 Report Structure

This thesis is organised through eight chapters (Chapter 1-8.) which is summarised in the next paragraph.

The research project, its underlying motivations, background and hypothesis have been introduced in the current chapter (Chapter 1). A systematic review of the inclusion of SMFs in behavioural interventions is presented in Chapter 2. Chapter 3. reports on the results and findings of a focus group study aimed at understanding the expectations of intervention builders with respect to SMFs described in behavioural interventions. Chapter 4. presents a taxonomy of SMFs for behavioural interventions based on the findings on the previous chapters (2. & 3.).

Chapter 5. describes the design and implementation of a pilot experiment with a prototype SMF to demonstrate its feasibility and usability through an evaluation using data collected from end-users. The design and implementation of an architecture to facilitate the inclusion and customisation of SMFs in behavioural interventions in presented in Chapter 6. An experiment to demonstrate and evaluate this generic framework is described in Chapter 7. Finally, the contributions of this research work are presented in the conclusion (Chapter 8.) along with the future avenues of research and recommendations.

Chapter 2. Systematic Review of Social Media Features in Behavioural Interventions

A recent review which examined the use of Online Social Networks (OSNs) in health behaviour change interventions identified ten research studies matching their set of criteria [35]. The use of social media features in DBCIs is an area of research that requires further examination. Two reviews exist which applied different search criteria that did not seek to capture the full range of social media features included within DBCIs, such as online forums, chatrooms, blogs, etc which are not always defined within OSNs [35, 40] . Systematic reviews with regards to the use of social media features in DBCIs which have been published tend to target only one [41, 42] or two [43] out of the four behavioural risk factors published by the World Health Organisation (WHO) as leading risk factors for global disease burden which include tobacco smoking, alcohol use, physical inactivity and diet [44]. This makes it hard to facilitate comparison across behaviours. While there exist a large number of SMFs which can be used in DBCIs, each one of them may have varying benefits to end-users based on the context and behaviours being addressed. Such patterns can be analysed through a large-scale systematic review of studies reporting on behavioural interventions.

The review presented in this thesis systematically identifies and analyses peer-reviewed publications of digital behaviour change interventions that include SMFs or OSNs which target tobacco smoking, diet & nutrition, physical activities or alcohol consumption. This creates an opportunity to have a better understanding about their effectiveness, and how this differs for the various targeted behaviours.

2.1 Overview

A systematic literature review has been undertaken to understand how SMFs are used in DBCIs and their reported impact on participants or on the interventions' outcomes. This review is crucial due to the lack of published comparative information in relation to SMFs in DBCIs as reported in Chapter 1. During the reviewing process, a Taxonomy of Social Media features (See Chapter 4.) was also being developed to help categorise SMFs that were identified in the reviewed studies. The current chapter helps us address our first research question which is "Do *behavioural interventions that integrate SMFs have positive effects on end-users?"*

2.2 Methods

The methods used to identify and analyse relevant behavioural interventions are described in this section.

2.2.1 Information Sources

Literature searches were conducted in the following health-related and multi-disciplinary databases to ensure both the technical and behavioural aspects of interventions could be captured: Web of Science, Scopus, Engineering village, Medline, ERIC, CINAHL, PsycINFO, ProQuest and Cochrane. Combined variants of relevant terms from the social media and digital behaviour change interventions domains were used to build a search query (e.g. common social media terms such as "facebook", "forum", etc…, combined with terms such as "online", "web", etc. and target behaviours such as "diet", "smoking", etc.". After refinements by two independent researchers, the finalised search query (see Table 1.) was used to conduct the searches. The search was conducted on the 30th of November 2015.

1. Social Media	social network* OR social feature* OR social tool* OR social component* OR social media OR social support OR peer support OR facebook OR linkedin OR twitter OR badoo OR orkut OR myspace or youtube or Instagram OR poll* OR survey* OR questionnaire* OR group* OR messag* OR leader board* OR rank* table* OR profile OR forum OR quiz OR diary OR diaries OR knowledge repositor* OR progress viewing OR notification* OR rival nomination OR goal setting OR sharing OR comment* OR feed* OR reminder* OR self-reporting tool* OR planner* OR chat*
2. Internet	online OR web OR internet
3. Mobile	smartphone OR mobile OR android OR iphone
4. Intervention	behaviour change intervention* OR behavior change intervention* OR digital intervention*
5. Target Behaviours	(alcohol OR binge drink* OR healthy eating OR nutrition OR diet* OR , exercis* OR sport* OR sedentary* OR physical OR inactiv* OR motor activit* OR tobacco OR smoking OR nicotine OR weight loss)
6. Combined	1 AND (2 OR 3) AND 4 AND 5
Query:	(social network* OR social feature* OR social tool* OR social component* OR social media OR social support OR peer support OR facebook OR linkedin OR twitter OR badoo OR orkut OR myspace or youtube or Instagram OR poll* OR survey* OR questionnaire* OR group* OR messag* OR leader board* OR rank* table* OR profile OR forum OR quiz OR diary OR diaries OR knowledge repositor* OR progress viewing OR notification* OR rival nomination OR goal setting OR sharing OR comment* OR feed* OR reminder* OR self-reporting tool* OR planner* OR chat*) AND ((online OR web OR internet) OR (smartphone OR mobile OR android OR iphone)) AND (behaviour change intervention* OR behavior change intervention* OR digital intervention*) AND (alcohol OR binge drink* OR healthy eating OR nutrition OR diet* OR , exercis* OR sport* OR sedentary* OR physical OR inactiv* OR motor activit* OR tobacco OR smoking OR nicotine OR weight loss)

Table 1 Search Query Construction for Literature Search

2.2.2 Screening Process

The search results were downloaded, combined and sorted for an initial filtering to remove duplicates. Two independent reviewers then went through separate but identical copies of the result-set of unique entries and flagged non-relevant ones based our inclusion/exclusion criteria

by going through their titles and abstracts. Differences were then resolved through consultation. The same reviewers conducted a subsequent eligibility screening of the remaining full text articles.

To be included in the review, studies had to be:

- in the form of published and peer-reviewed full-text articles from conferences and journal papers
- targeting at least one of the following modifiable behavioural risk factors published by the World Health Organisation (WHO): "Tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol" [44] .

No restrictions were placed on sample population used; participants from all age groups including minors, gender and health status were eligible for inclusion. Review papers for behavioural interventions which included references to studies matching our selection criteria were manually searched to identify studies that might have been missed in our initial search

A total of 143 publications were retained for data extraction and analysis as presented in Figure 2. based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Out of these, eight studies were reported through more than one publication (7 studies with 2 publications each and 1 study with 3 publications). Therefore, one hundred and thirty-four studies (N=134) were analysed.

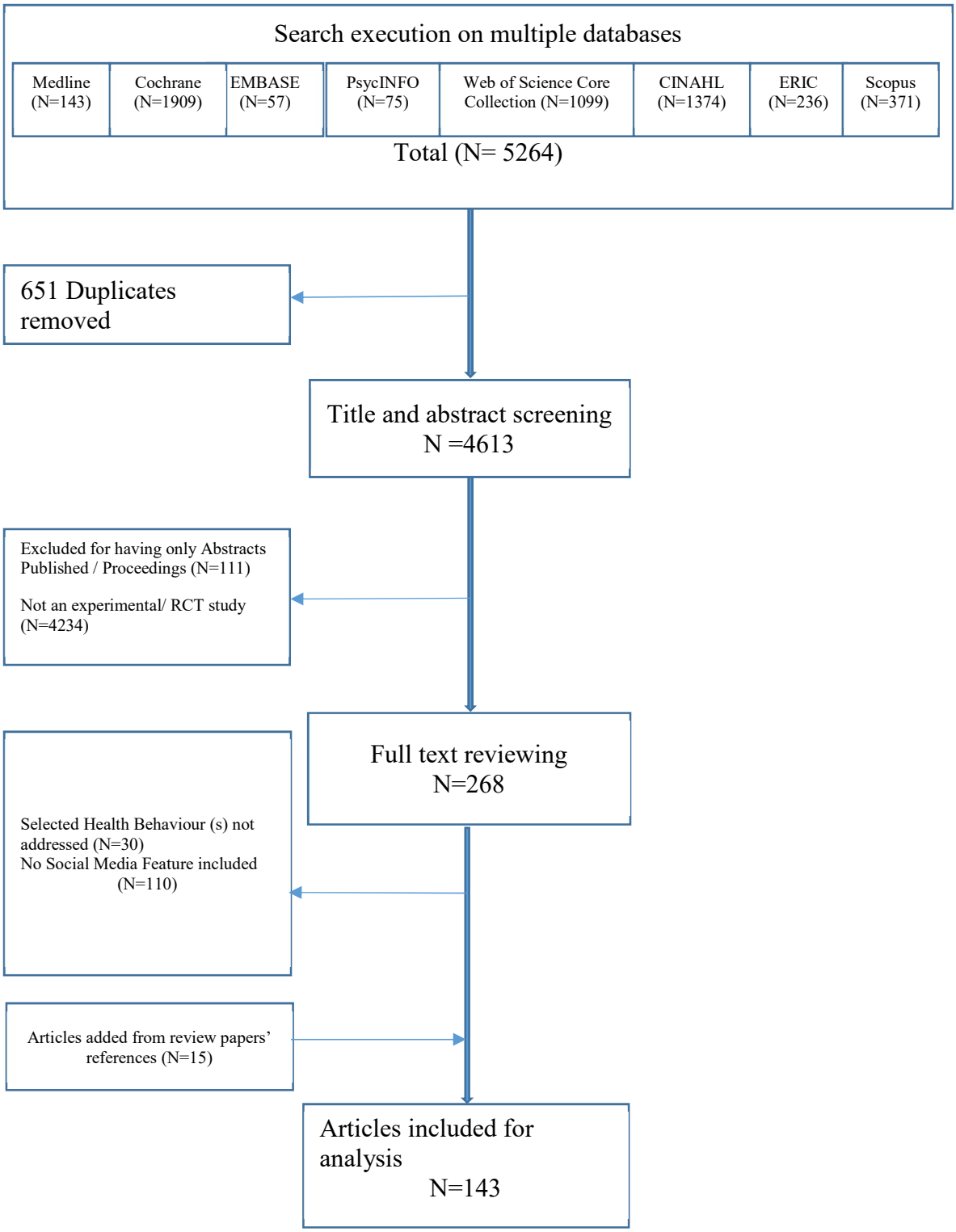


Figure 2. PRISMA Flow Diagram for Paper Selection Process

2.2.3 Data Extraction & Analysis

A data extraction table was used to record key details for each study being reviewed (see Appendix A. for SMFs identified in each publication reviewed). The complete dataset has been published online (DOI: 10.5258/SOTON/D0274). The outcome of each of the studies was classified as positive, neutral, or negative. This classification was done by comparing the objective(s) and hypothesis stated for the studies with their reported results and findings. For studies which adopted a Randomised-Control Trials (RCT) design, when their intervention arm(s) were more effective than their control arm(s) by either the extent of change in behaviour and/or the number of participants successfully adopting healthier behaviours, they were considered as having a positive outcome. In cases where no significant difference was reported between the intervention and control arms, the studies were considered as having a neutral outcome. Finally, for studies in which the control arm(s) were more effective in improving participants' behaviour than the intervention arm(s), the outcome was classified as negative. However, in the last situation, the reason(s) behind the control group outperforming the intervention arm would require further investigation which is out of the scope for this review. Similarly, the same methods were adapted for studies with experimental / pre-post designs by comparing the initial objective(s) and hypothesis with the studies' findings.

The data table was analysed for patterns of social media features inclusion in the different interventions in order to determine whether there was any correlation with the studies' outcomes. The data was also used to inform the development of the taxonomy of social media features described in Chapter 4 of this thesis. The taxonomy consists of seven high level categories as listed below:

1. Identity Representation
2. Communication
3. Peer Grouping
4. Data Sharing
5. Competitive
6. Activity Data Viewing
7. Online Social Network

Each of these categories then groups a number of sub-categories or social media features. Refer to the corresponding chapter for a full description of the taxonomy along with its development processes.

2.3 Results

The results of the systematic review are presented below, starting with an overview of the studies retained for analysis.

2.3.1 Studies Characteristics

A breakdown of the 134 studies reviewed categorised by their targeted behaviours is shown in Table 2. The majority of the studies targeted physical activity, either as a single behaviour or in combination with other behaviours such as Diet & Nutrition. Alcohol consumption was addressed by the fewest number of studies.

Addressed Behaviours	N	%
Alcohol Consumption	5	3.73%
Diet & Nutrition	7	5.22%
Diet & Nutrition + Physical Activity	11	8.21%
Diet & Nutrition + Physical Activity + Alcohol Consumption	1	0.75%
Physical Activity	38	28.36%
Physical Activity + Smoking Cessation	1	0.75%
Smoking Cessation	25	18.66%
Weight loss/ Weight Maintenance + Diet & Nutrition	3	2.24%
Weight loss/ Weight Maintenance + Diet & Nutrition + Physical Activity	43	32.09%
Total Number of Studies Analysed	**134**	**100%**

Table 2. Breakdown of Number of Studies by Addressed Behaviours

The outcome of each of these studies were have been classified as positive, neutral, or negative as explained in the Methods section. The largest proportion of studies were classified as having a positive outcome (N=94) followed by a neutral outcome (N=37) and finally, negative outcome (N=3) as depicted in Figure 3.

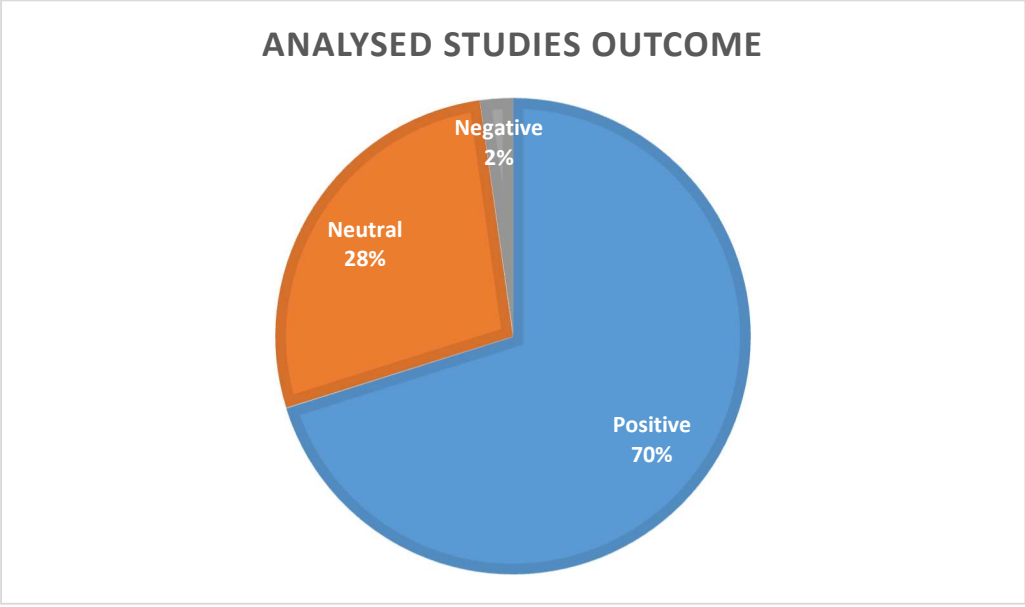


Figure 3. Outcome of studies included in analysis

2.3.2 Inclusion of Information related to usage and impact of Social Features

All the studies included in the analysis had to have at least included one social media feature that enabled some form of peer interaction in their interventions. However, only 72.4% of the studies (N=97) published additional information in their results and/or discussions as shown in Figure 4. while the remaining studies only mentioned the social media features that were included.

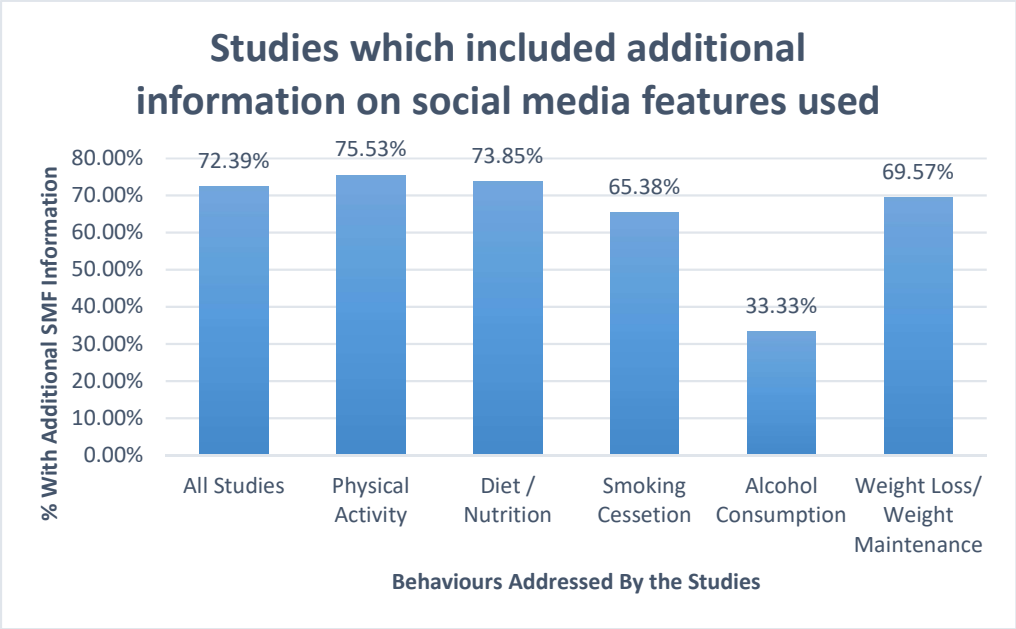


Figure 4. Percentage of studies which included additional information on social media features used

The type and amount of information provided about the social media features varied widely from one study to another, with some providing only usage data (e.g. frequency a feature was used, number of participants using it), impact-related information (e.g. whether the feature had an effect on how participants engaged with the intervention, attrition, did the feature contribute in modifying addressed behaviours), participants' perception about it (e.g. in terms of usefulness, satisfaction, helpfulness, social support derived) or a combination of these three elements. Similarly, the level of details varied from one descriptive sentence to a full data table and accompanying description.

None of the studies that reported on the social media features described any negative impact on the outcome of the interventions. Indeed, 69.1 % of the studies described the outcome of these features in positive terms and reported a range of effects attributed to their usage such as higher levels of engagement with the interventions, increased perception of usefulness and satisfaction as well as improvements in addressed behaviours attributed directly to the use of social media features. The remaining studies (N= 30) reported a low usage (<50% of participants using a social media feature) and / or neutral outcomes. There was not much

difference in terms of percentages when the studies were analysed as shown in Figure 5. with values ranging from 67.6% to 76.5% except for Alcohol Consumption (50%) which was based on only two studies.

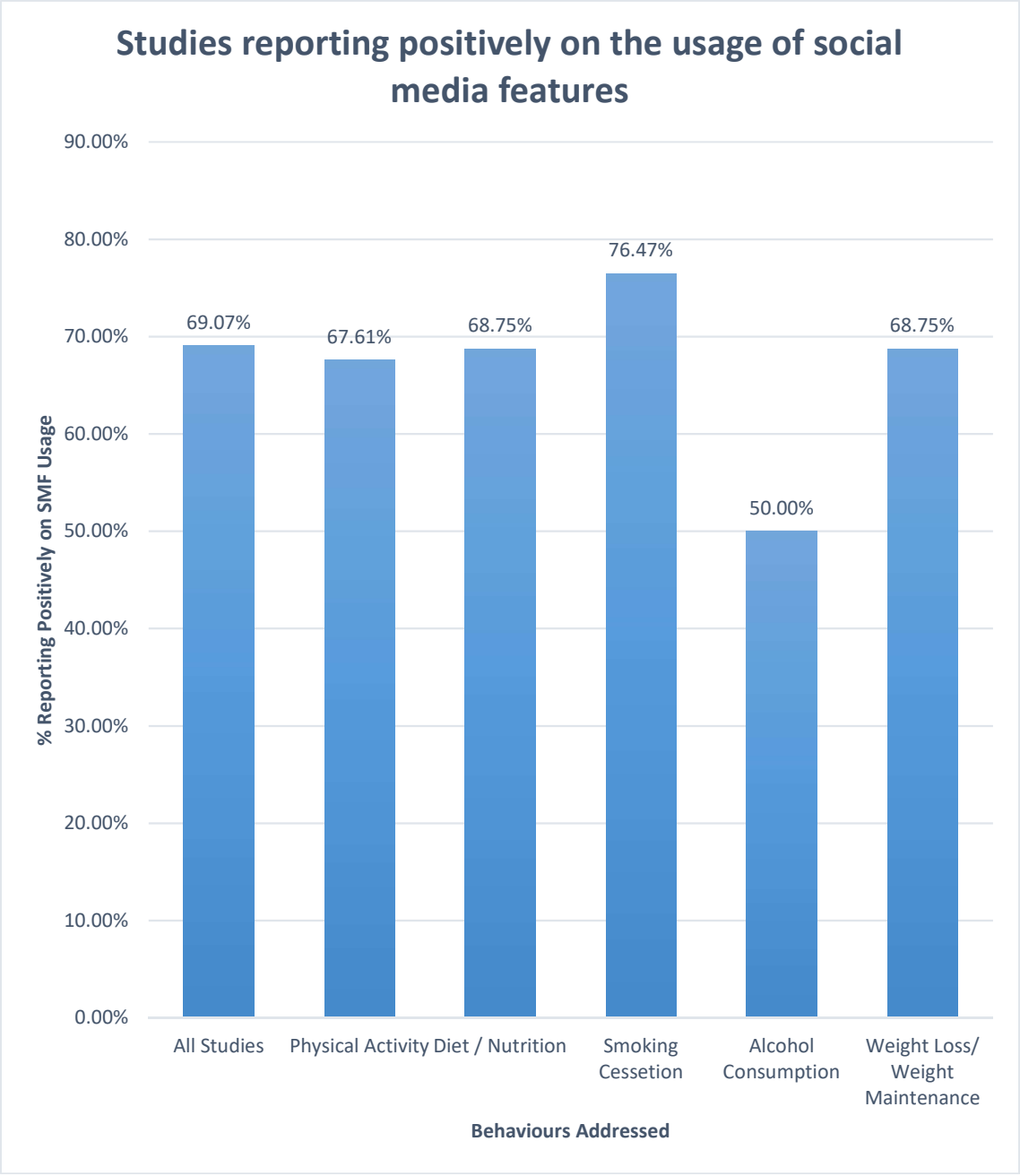


Figure 5. Percentage of studies reporting positive effects of social media features used

2.3.3 Social media features inclusion

A list of categories of social media features as described in our taxonomy (See Chapter 4.) was used to group them. These categories are: Identity Representation, Communication, Peer Grouping, Data Sharing, Competitive, Activity Data Viewing and Online Social Network. The clear majority of studies (92.54%) included at least one social media features which enabled

participants to communicate with one another as shown in Figure 6. With 41.79% of studies making use of a social feature from Peer Grouping, this category was the second most used after Communication and included features such as social connection (one-to-one friending/buddy nomination) and groups/teams in which participants were aware of one another. There is a strong connection between Communication and Peer Grouping as the latter ultimately facilitate communication among participants through a number of other social features available to social connections and groups. With the exception of the Competitive category, the other categories had their social features included between 27% and 34% of the time by studies. Social media features categorised as competitive were mostly used in interventions addressing physical activity only, compared to the other behaviours.

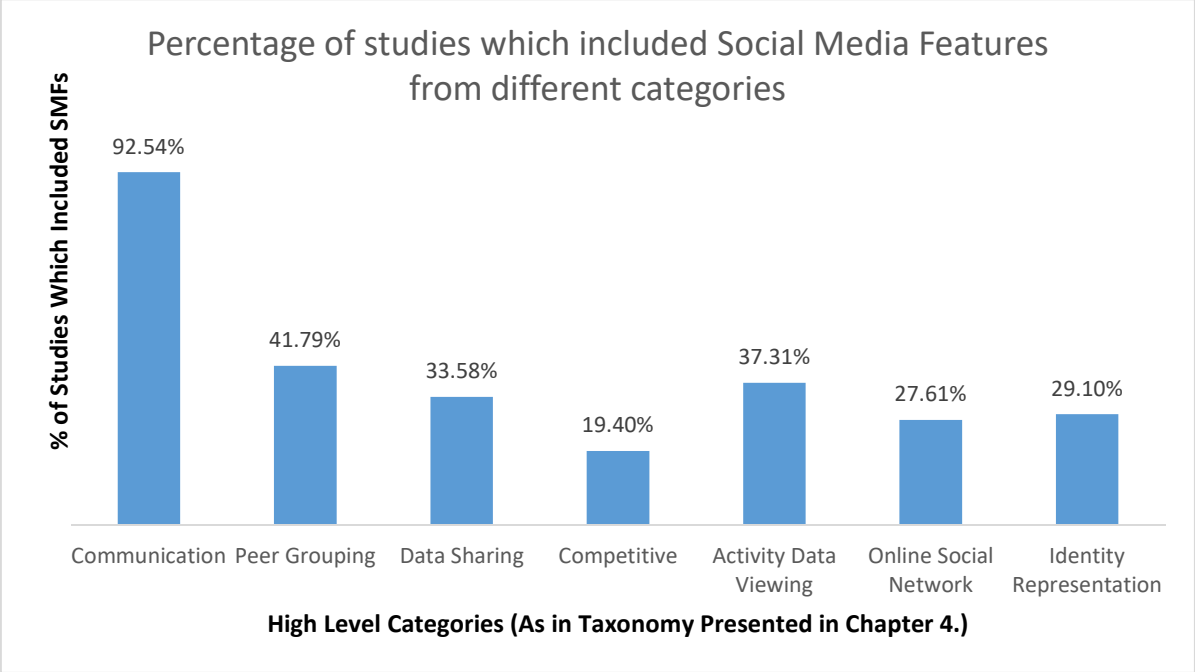


Figure 6. Percentage of studies which included social media features from the different categories

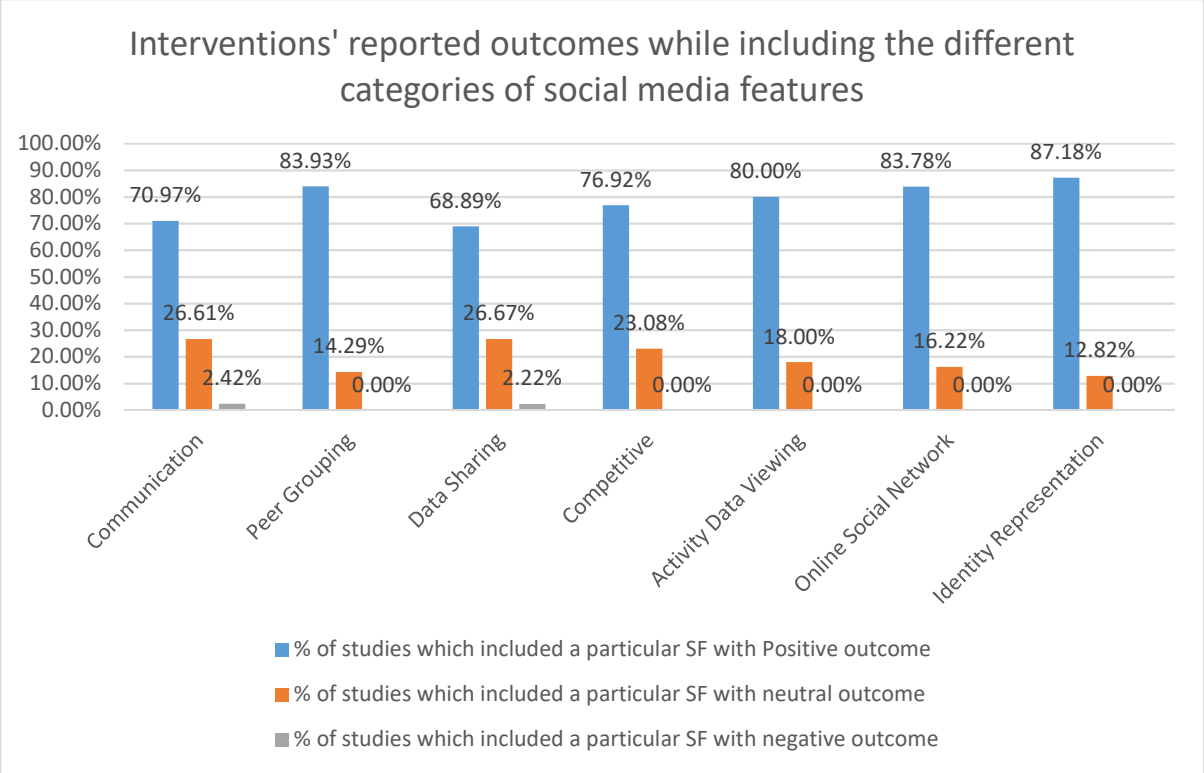


Figure 7.Intervention reported outcomes while including the different categories of social media features

Based on studies that did report on the social media features' effect, most of which were positive, on participants and in their contribution to successfully help improve their behaviours, it is quite likely that the inclusion of social media features contributes towards achieving positive outcomes. The different percentages of studies which included features from the different categories of social media features and which reported positive outcome is shown in Figure 7. On average, 78.81% of studies including social features from the different categories reported positive outcomes. The category with the highest inclusion percentage (87.18%), linked with positive outcomes was Identity Representation, under which user profiles and avatars were categorised. On the other hand, Data Sharing had the lowest percentage, with 68.89%.

With a more detailed view of the percentages of studies addressing different behaviours and their inclusion of social media features from the different categories as shown in Figure 8. , it becomes evident that there is not much difference in the popularity of specific categories associated with particular behaviours. The only exception with this trend would be for alcohol consumption which due to the low number of studies this behaviour that has included in this review, will have little statistical significance.

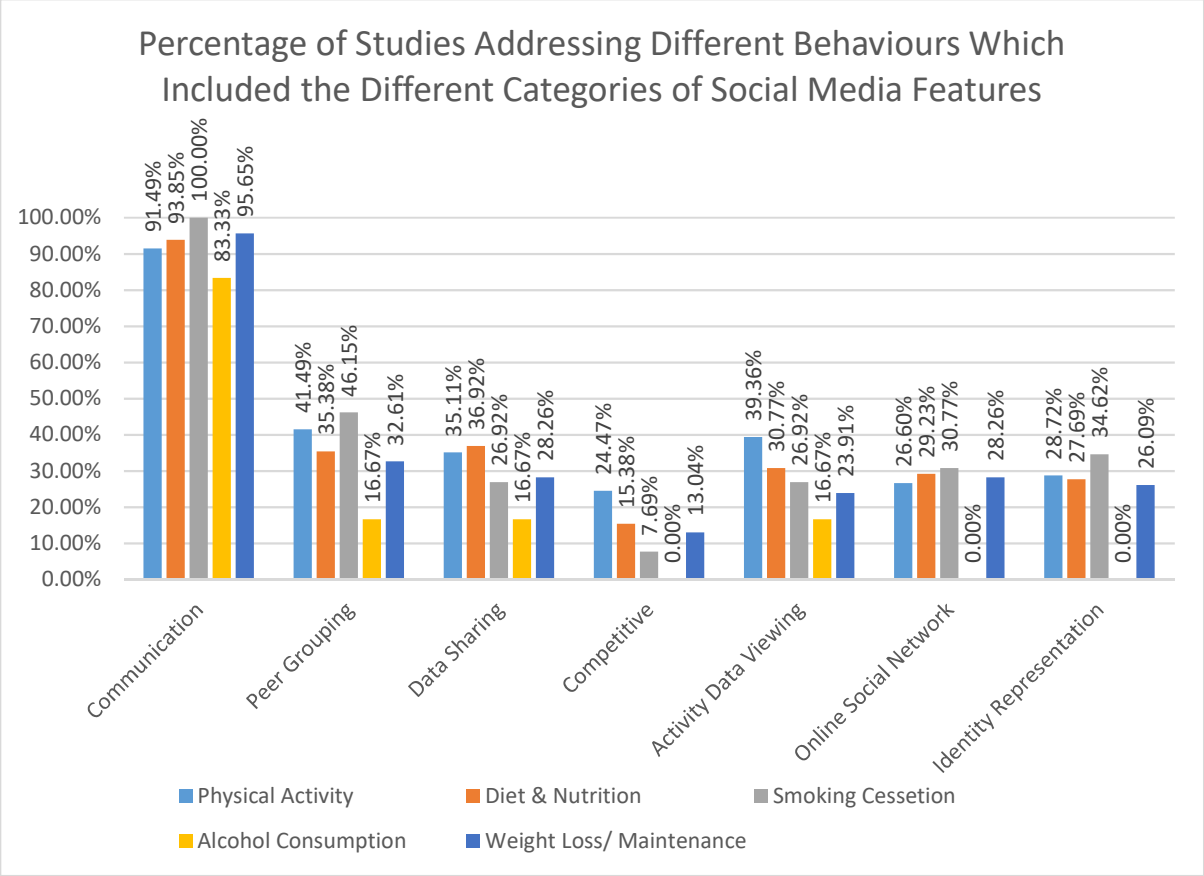


Figure 8.Percentage of Studies Addressing Different Behaviours Which Included the Different Categories of Social Media Features

While Figure 8. provided an overview of social media feature categories included in the reviewed studies, a more detailed, feature-specific inclusion is shown in Table 3. For each feature, the number and percentage of studies addressing each behaviour considered in the review is provided. This will help researchers and intervention designers make informed decisions as to which feature is more widely used for addressing certain behaviours. However, a high inclusion rate of certain SMFs does not always corelate to their effectiveness in targeting specific behaviours. It has not been possible to validate such detailed correlation due to the lack of published information about the effectiveness of the social media features in the reviewed studies.

Category/Sub-category	Social Media Feature	All Behaviours	Physical Activity	Diet/ Nutrition	Smoking Cessation	Alcohol Consumption	Weight Loss/ Maintenance
		N (%)					
Identity Representation	User Profile	35 (26.1%)	23 (24.5%)	17 (25.8%)	9 (34.6%)	0 (0.0%)	11 (23.4%)
	Avatar	9 (6.7%)	7 (7.4%)	3 (4.5%)	2 (7.7%)	0 (0.0%)	2 (4.3%)
Communication >> Many to Many >> Synchronous	Chatroom (Text-based)	22 (16.4%)	13 (13.8%)	14 (21.2%)	6 (23.1%)	2 (33.3%)	11 (23.4%)
	Group Video Conferencing	3 (2.2%)	3 (3.2%)	2 (3.0%)	0 (0.0%)	0 (0.0%)	2 (4.3%)
Communication >> Many to Many >> Asynchronous	Online forum	78 (58.2%)	58 (61.7%)	41 (62.1%)	16 (61.5%)	3 (50.0%)	32 (68.1%)
	Mailing list	5 (3.7%)	3 (3.2%)	3 (4.5%)	1 (3.8%)	1 (16.7%)	2 (4.3%)
	Peer commenting	33 (24.6%)	21 (22.3%)	16 (24.2%)	8 (30.8%)	0 (0.0%)	10 (21.3%)
	Social Notice Board (Group walls)	18 (13.4%)	12 (12.8%)	11 (16.7%)	2 (7.7%)	0 (0.0%)	7 (14.9%)
Communication >> One to One	Text chatting	19 (14.2%)	13 (13.8%)	9 (13.6%)	2 (7.7%)	1 (16.7%)	6 (12.8%)
	Peer SMS	7 (5.2%)	3 (3.2%)	2 (3.0%)	4 (15.4%)	1 (16.7%)	1 (2.1%)
	Peer Web Messaging / Emailing	33 (24.6%)	23 (24.5%)	17 (25.8%)	6 (23.1%)	1 (16.7%)	14 (29.8%)
	Video Call	1 (0.7%)	1 (1.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Communication >> One-way	Symbolic Support	22 (16.4%)	12 (12.8%)	10 (15.2%)	6 (23.1%)	0 (0.0%)	6 (12.8%)
	Social Tagging	3 (2.2%)	2 (2.1%)	2 (3.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Peer Data Rating / Evaluation	1 (0.7%)	0 (0.0%)	1 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Peer Grouping	Online Teams/ clubs/ groups	9 (6.7%)	9 (9.6%)	2 (3.0%)	0 (0.0%)	0 (0.0%)	1 (2.1%)
	OSN-based groups	14 (10.4%)	9 (9.6%)	7 (10.6%)	2 (7.7%)	0 (0.0%)	5 (10.6%)

	One-to-one social connections (friending/buddy nomination)	50 (37.3%)	33 (35.1%)	22 (33.3%)	12 (46.2%)	1 (16.7%)	14 (29.8%)
Data Sharing	Activity Data	21 (15.7%)	17 (18.1%)	6 (9.1%)	3 (11.5%)	0 (0.0%)	4 (8.5%)
	Goal Data	6 (4.5%)	1 (1.1%)	0 (0.0%)	5 (19.2%)	0 (0.0%)	0 (0.0%)
	Poll Voting	8 (6.0%)	4 (4.3%)	6 (9.1%)	2 (7.7%)	0 (0.0%)	4 (8.5%)
	Blogs /Testimonial/ Experience Sharing	16 (11.9%)	8 (8.5%)	8 (12.1%)	6 (23.1%)	1 (16.7%)	6 (12.8%)
Competitive	Social Quiz	3 (2.2%)	2 (2.1%)	2 (3.0%)	1 (3.8%)	0 (0.0%)	0 (0.0%)
	Social Rewards	11 (8.2%)	11 (11.7%)	4 (6.1%)	0 (0.0%)	0 (0.0%)	3 (6.4%)
	Social Challenge	5 (3.7%)	5 (5.3%)	2 (3.0%)	0 (0.0%)	0 (0.0%)	1 (2.1%)
	Activities & Contests (Team-based)	3 (2.2%)	3 (3.2%)	1 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Activities & Contests (Individual-based)	12 (9.0%)	10 (10.6%)	5 (7.6%)	1 (3.8%)	0 (0.0%)	4 (8.5%)
Activity Data Viewing >> Peer Data Comparison	Leaderboard / Ranking Table	8 (6.0%)	8 (8.5%)	2 (3.0%)	0 (0.0%)	0 (0.0%)	1 (2.1%)
	Other Textual Comparison	10 (7.5%)	9 (9.6%)	2 (3.0%)	1 (3.8%)	0 (0.0%)	1 (2.1%)
	Graphical/Video-based Comparison	7 (5.2%)	7 (7.4%)	3 (4.5%)	0 (0.0%)	0 (0.0%)	2 (4.3%)
	Social Norm / Aggregated Data Comparison	8 (6.0%)	6 (6.4%)	3 (4.5%)	0 (0.0%)	1 (16.7%)	0 (0.0%)
Activity Data Viewing >> Peer Data Updates	Social Notification	3 (2.2%)	2 (2.1%)	1 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Feeds	26 (19.4%)	17 (18.1%)	12 (18.2%)	6 (23.1%)	0 (0.0%)	8 (17.0%)
Online Social Network	Generic & Conventional	16 (11.9%)	11 (11.7%)	8 (12.1%)	2 (7.7%)	0 (0.0%)	6 (12.8%)
	Virtual World	17 (12.7%)	12 (12.8%)	9 (13.6%)	4 (15.4%)	0 (0.0%)	6 (12.8%)
	Purpose-Designed	4 (3.0%)	2 (2.1%)	2 (3.0%)	2 (7.7%)	0 (0.0%)	1 (2.1%)

Table 3. Inclusion of specific social media features by behaviour

When considering which addressed behaviours had the highest inclusion rate for each social media feature, Physical Activity and Smoking Cessation each had 11 highest inclusion rate instances followed by Dieting / Nutrition and Alcohol Consumptions with 5 instances each and finally 3 instances for Weight Loss /Maintenance. The set of social media features that were the most included ones remained unchanged across all the behaviours considered in this review except for Alcohol Consumption. These were Online Forums, Social Connections and User Profiles.

Social media features under the Communication category remained the most popularly included across all the five behaviours considered in this review. Most of the studies included at least one social media feature based on communication and with a consistent inclusion rate, six out of ten studies in this review have made use of online forums as part of their interventions.

Features from the Identity Representation category and Peer Grouping category were more prevalent in interventions which addressed Smoking Cessation compared to other behaviours with none of the interventions which targeted alcohol consumption using any of the features from this category.

Physical Activity-related interventions was the most likely to include social media features from the Competitive category through Social Rewards. However, the highest inclusion rate from this category was below 12%. While none of the interventions which addressed Alcohol Consumption included Competition-based features, only two Smoking Cessation intervention used the Social Quiz and Activities & Contests (Individual-based) features.

For the Activity Data Viewing >> Peer Data Comparison category, Interventions addressing Physical Activity were the most likely to include these features compared to other behaviours with only one study in alcohol consumption and another from smoking cessation including a feature from this category.

OSNs of Generic & Conventional types were most popular in studies addressing Weight Loss / Weight Maintenance, followed closely by Diet & Nutrition and Physical Activity interventions. On the other hand, Virtual Worlds were included the most in interventions addressing Smoking Cessation. Although there was not much difference in the inclusion rate for Purpose-designed OSNs for the four behaviours, studies which targeted smoking cessation used them the most.

2.3.4 Social Media Features and Behavioural Outcomes

The majority of studies were classified as having positive outcomes (N=94, 70%) followed by neutral outcomes (N=37, 28%) and negative outcomes (N=3, 2%). Table 4. presents an analysis of the prevalence of social features by study outcome. As discussed for the data presented in Table 3., the outcomes for the studies should not be considered as corelated to their inclusion of certain social media features. However, there is a possibility that the features had an impact on the overall outcomes of the behavioural interventions.

	Communication	Peer Grouping	Data Sharing	Competitive	Activity Data Viewing	Online Social Network	Identity Representation
Studies irrespective of outcome	124	56	43	26	50	37	39
Studies with Positive outcome	88 (71.0%)	47 (83.9%)	40 (93.0%)	20 (76.9%)	40 (80.0%)	31 (83.8%)	34 (87.2%)
Studies with neutral outcome	33 (26.6%)	9 (16.1%)	2 (4.7%)	6 (23.1%)	10 (20.0%)	6 (16.2%)	5 (12.8%)
Studies with negative outcome	3 (2.4%)	0 (0.0%)	1 (2.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table 4. Interventions reported outcomes while including social media features from the different categories

Most of studies which included social media features reported positive outcomes with the lowest percentage being 71% for the Communication category and the highest at 93% for Data Sharing. Out of the 134 studies reviewed, only 4 studies reported negative outcomes. This trend was consistent across all the five behaviours considered as shown in Table 5.

	Communication	Peer Grouping	Data Sharing	Competitive	Activity Data Viewing	Online Social Network	Identity Representation
Physical Activity							
% positive	57 (66.3%)	31 (79.5%)	24 (88.9%)	17 (73.9%)	28 (75.7%)	19 (76.0%)	22 (81.5%)
% neutral	26 (30.2%)	8 (20.5%)	2 (7.4%)	6 (26.1%)	9 (24.3%)	6 (24.0%)	5 (18.5%)
% negative	3 (3.5%)	0 (0.0%)	1 (3.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Dieting / Nutrition							
% positive	44 (71.0%)	19 (82.6%)	17 (94.4%)	7 (70.0%)	15 (75.0%)	17 (89.5%)	16 (88.9%)
% neutral	16 (25.8%)	4 (17.4%)	1 (5.6%)	3 (30.0%)	5 (25.0%)	2 (10.5%)	2 (11.1%)
% negative	2 (3.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Smoking Cessation							
% positive	21 (80.8%)	12 (100.0%)	11 (100.0%)	2 (100.0%)	7 (100.0%)	8 (100.0%)	9 (100.0%)
% neutral	5 (19.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
% negative	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Alcohol Consumption							
% positive	4 (80.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)
% neutral	1 (20.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
% negative	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Weight Loss/ Maintenance							
% positive	33 (73.3%)	12 (80.0%)	11 (91.7%)	5 (83.3%)	9 (81.8%)	11 (84.6%)	10 (83.3%)
% neutral	10 (22.2%)	3 (20.0%)	1 (8.3%)	1 (16.7%)	2 (18.2%)	2 (15.4%)	2 (16.7%)
% negative	2 (4.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table 5. Studies Addressing Different Behaviours and Reported Positive, Neutral or Negative Outcomes

Studies which included social media features from the Data Sharing Category were more likely to report positive outcomes for all the behaviours considered compared to features from other categories. For example, one intervention which addressed Physical Activity, Diet & Nutrition and Weight Loss / Weight Maintenance enabled participants to use Blogs to share their personal experience [36]. In-line with this, Testimonial sharing was included in several studies addressing smoking cessation [45-48] which encouraged participants to share their own experience with others. Most of these studies also enabled the sharing of smoking quit goals

among one another. While in most studies, data sharing through the variety of features under this category was initiated by participants, at least one study [49] addressing Physical Activity, provided a functionality for participants to request others to share their data which in that case was step counts. Haines-Saah et al., [50], who used an OSN-based private group (peer-grouping category), for enabling participants to post photos (Data Sharing category), reported a gender-bias in terms of engagement whereby female participants tended to share more pictures and remained engaged for a lengthier period of time.

This was followed by Identity Representation and Online Social Networks, both of which had significant overlaps due to the fact that OSNs were often used as a container for other social media features, with Identity Representation, consisting of a User Profile and Avatar often being included. The most prevalent OSNs were QuitNet for studies addressing Smoking Cessation and Facebook for other behaviours. Studies which included features from the Communication category reported higher levels of neutral and negative outcomes across the different behaviours compared to the other categories. Except for features from the Communication category, studies addressing Smoking Cessation all reported positive outcomes (100%) for the other categories.

2.3.5 Reported Impact of Social Media Features

72.4% of the studies (N=97) reviewed, published additional information about social media features that were included in their interventions in their results and/or discussions. However, despite the high percentage, the type and amount of information provided about the social media features varied widely from one study to another, ranging from usage data (e.g frequency a feature was used, number of participants using it), impact-related information (e.g whether the feature had an effect on usage or behavioural outcomes) and participants' perceptions (e.g usefulness, satisfaction, helpfulness, social support derived). Similarly, the level of details varied from one descriptive sentence (e.g. The study by Block et al.,[51] and Sternfield et al.,[52])to a full paragraph of text providing each social media feature's statistical data and accompanying description (e.g. The intervention by Napolitano et al. [53]).

None of the studies that explicitly reported on the social media features described any negative impact on the outcome of the interventions. Indeed, 69.1 % of the studies described the outcome of these features in positive terms and reported a range of effects attributed to their usage such as higher levels of engagement with the interventions, increased perception of usefulness and satisfaction as well as improvements in addressed behaviours attributed directly to the use of social media features. The remaining studies (N= 30) reported low usage (<50% of participants using a social media feature) and / or neutral outcomes.

2.3.5.1 Usage

The inclusion of different types of social media features has been reported to be associated with increased user engagement in behavioural interventions as described below.

Communication

Asynchronous features from the Communication category (e.g. online forums) were reported to support increases in usage and engagement [6, 54-58] while studies which included synchronous features (e.g, Online Video and Chatrooms) for meetings [59-64], mostly reported no effect or reduced engagement when compared to controls (face-to-face). Interestingly, it was reported that female participants tended to engage in online group discussions more than their male counterparts [65]. Online forums have also been found to encourage usage over lengthier periods [6].

Peer Grouping & Data Sharing

Engagement was also found to be gender-biased in an OSN-based private group where participants could post photos, with females sharing more pictures and remaining engaged for lengthier periods of time [50]. Social connections, were found to contribute towards motivating participants to engage more with the interventions [4, 66-68]. Similar findings were also reported for peer-led support leading to an increase in the frequency of participants visiting an intervention's website [69].

Along with peer-grouping-based features, interventions commonly included Data Sharing features [50, 68, 70]. The inclusion of polls was found to promote engagement the most compared to other types of textual or graphical data [70] while the ability to create social connections to share each other's activity data [68] or the use of an OSN-based private group to share photos [50] also produced high levels of engagement among their participants.

Competitive & Activity Data Viewing

Competitive elements such as social challenges in interventions addressing Physical Activity was also found to promote engagement [66]. Linked with the competitiveness, the use of Leader Boards / Ranking tables from the Activity Data Viewing category, caused participants who were interested with their ranking to access the intervention's application more often [71]. Similarly, the inclusion of Graphical Based comparisons [68] led to increases in user engagement.

Online Social Networks (OSNs)

It was reported that participants spent more time using an intervention which included an OSN platform [72]. Indeed, higher levels of engagements from participants were observed when OSNs were included along with their accompanying social media features [36, 73]. However, this had no effect on attrition or retention rates [36, 70].

2.3.5.2 Participants' perceptions: social support, helpfulness, satisfaction and motivation

The use of Social media features in behavioural interventions have been associated with enhanced social support and motivation perceived by participants in several studies.

Most of these studies included features from the **Communication** category such as online forums and chatrooms. While some of those which included online forums reported positive perceptions of social support among participants [74-76], there was also the possibility of no change [77] and even a demotivating effect based on content quality shared by participants [77, 78]. Forums were often found to be useful/helpful by a majority of participants [74, 79-81], although in some studies this dropped to below 50% of participants [82-84]. The lower percentages was attributed to a "lack of critical mass" in the number of participants engaging actively in the forums to change other's perception positively [83] or could be based on participants' preferring personal email counselling compared to peer to peer support from online forums [85]. It was reported that participants actively sought social support from peers through chatrooms and derived positive perception of social support [76, 86] but this perception was lower compared to in-person group meetings [64]. Other features that were associated with positively enhancing participants' perception were group video chatting [60], mailing list [86], peer commenting [87], peer emailing [76], peer SMS [88-90], text chatting (one-to-one) [91] and Symbolic support [87].

Peer Grouping features were also found help improve social support perceptions. Participants with access to these features had higher levels of social support coping [75, 88, 89, 92, 93]. However, this could also be attributed to participants feeling pressured in meeting goals or enjoying recognition and encouragements from peers [49, 92, 94]. Similarly to content quality affecting motivation, social connections could have a demotivating factor in cases where the social support originate from better performing peers [95].

Data Sharing and Peer Data Viewing had positive effects on perception of social support and motivation specially when peers provided feedback [49, 67, 75, 88, 93, 94, 96]. However, Data Sharing was not always attributed with enhanced social support, with reporting mixed effects when support originated from non-participants (external supporters) and their inability in

constructing motivating messages [90] or possible concerns from participants about the usefulness to peers for the data being shared [82, 97]. A positive correlation between the level of social support and the activeness of participants in data sharing activities for an intervention addressing Diet & Nutrition reported [87].

The inclusion of **Competitive**-based features in interventions were more likely to have a positive effect on participants' perception of social support motivation levels in an intervention that addressed Physical Activity as at least one of its behaviours addressed [68, 76] but this was not always the case [94]. While rarely used in addiction-related behaviours, a competitive-based feature in the form of a quit-smoking contest in an intervention addressing Smoking Cessation, was perceived as "somewhat valuable" and had a low usage rate (35.3%) [94].

The only study among the reviewed articles to report on the impact on social support associated with the inclusion of **OSN** in behavioural interventions, found no change in social support perception [77]. However, OSNs were among the most reported upon feature for perceived usefulness [36, 50, 70, 79, 98]. While at least two interventions [36, 79] used purpose-designed OSNs, Facebook was used as the OSN in the other interventions [50, 70, 98]. This perception of usefulness could likely be also linked to the prevalent popularity of Facebook as a generic OSN platform among individual users. Another interesting finding was the increased credibility perception among participants when a Virtual-World type OSN with a recreated classroom along with an instructor avatar was used in an intervention addressing Diet & Nutrition and Physical Activity [99].

2.3.5.3 Behavioural outcome

A total of twenty-nine studies reported on the effectiveness of some of the social media features included in their interventions in contributing to change participants' behaviours. These features were from five of the high-level categories in our taxonomy, namely, Identity Representation, Communication, Peer Grouping, Activity Data Viewing and Online Social Networks.

Communication-based social media features included in behavioural interventions, were among the most reported for their effectiveness in modifying behaviours. Interaction among participants through asynchronous features such as forums were reported to have led to behaviour change in at least four studies [54, 69, 100-102] which addressed Physical activity, Diet & Nutrition and/or Weight Loss. However, in at least one study, this change was minimal and only found among female participants [100]. Forums were among the most reported in studies addressing smoking cessation with regards to its effect in changing participants'

behaviour positively [46, 47], although, in at least one case, no effect was found [58]. Chatrooms, enabling synchronous communication among participants were also reported to effectively modify behaviour in some studies. Among interventions which addressed Physical Activity, Diet & Nutrition and Weight Loss / Weight Maintenance, chatrooms were found to be effective in two interventions [101-103] while no effect were observed in others [61-63]. Smoking Cessation interventions could also benefit from their effectiveness as it has been reported that participants with access to chatrooms were more likely to report abstaining from smoking [104]. One-to-One Communication-based features have been reported to increase abstinence rates [45, 48], increase physical activity and lead to weight lost [105].

The use of **Peer Grouping**-based features were found to result in effective behaviour change in terms of weight loss among studies addressing Weight Loss/ Maintenance, Diet & Nutrition and Physical Activity [7, 103, 106-108], increase in activity levels for studies which addressed only physical activity [68, 95, 109, 110] and also increase in the likeliness of quitting smoking in Smoking Cessation interventions [46, 48, 92].

Activity Data Viewing was also reported to have a positive impact on behaviour change among studies addressing Physical Activity; Social interactions through games and allowing viewing of peers' performance [111, 112] led to increases in physical activity levels.

OSNs used as part of behavioural interventions were also associated with positive behaviour change, specially for weight loss [103, 105, 107, 113-115] although this was not always the case [36]. These studies all addressed multiple behaviours, namely: Physical activity, Diet & Nutrition and Weight Loss / Weight Maintenance. Improvements in dietary awareness was also attributed the use of OSNs [116]. OSNs which included user profiles was also found to encourage participants to smoke less and cause an increase in intentions to quit [104, 117].

2.4 Discussion

This review found that the majority of studies targeted either Physical Activity or a combination of behaviours which included Physical Activity (e.g Physical Activity, Diet & Nutrition and Weight Loss /Weight Maintenance). Following this trend, Physical Activity along with Smoking Cessation interventions had the highest prevalence of social media features. Among these features however, some were consistently more popularly included than others across all the different behaviours considered. Furthermore, our analysis revealed that most behavioural interventions which included social media features reported positive (>70%) outcomes with respect to their set of objectives and hypothesis. Interventions which included social media features from the Data Sharing Category had the highest positive outcome percentages (>88.9%). The main effects identified to be associated with the inclusion of social

media features in behavioural interventions were about usage/engagement of participants, enhanced perception of social support, helpfulness, satisfaction and motivation and thirdly, behavioural outcome. This discussion focuses on the patterns of social media feature types inclusion in behavioural interventions and potential areas to be addressed in future research.

While it cannot be ascertained based on this review alone whether most behavioural interventions address combinations of behaviours that include Physical Activity, it was clear that interventions addressing these behaviours and which included social media features were the most common, which could be due to them being better suited to drawing on social behaviour change techniques compared to addiction-related behaviours such as smoking and alcohol consumption. With a majority of these studies producing positive outcomes, this is in-line and adds the findings of McCully et al.'s survey [19] which reported an increasing viability for using the Internet as a platform for delivering behavioural interventions on large-scales. However, it should be pointed out that in most of the reviewed studies, their outcomes were not always explicitly attributed to the impact of the social media features that were included as was also reported in Tammy Chang et al.'s review [41]**.** However, based on the studies that did include relevant information attributed to the impact of social media features on users and the majority of which reported on the positive effects of these features, this can be assumed to be the case for the other studies mentioned previously as well.

Additionally, the studies reviewed were found to be using non-standard ways of reporting on the social media features by using different names to refer to the same social media feature and with varying levels of details. For example, online forums were also referred to as Messaging Board, Bulletin Board, Discussion Forum, Discussion Board etc. In terms of description; these forums were sometimes moderated by intervention counsellors but not all studies described whether these features were moderated and/or the extent that counsellors were involved in the group discussions for example. Some studies made use of generic online social networking sites such as Facebook and QuitNet, where a large number social features were available to the intervention participants without the researchers necessarily describing them; these features were however included in our analysis. These issues closely relates to the justifications put forward by Michie et al.,[118] which led to the proposal of a taxonomy for the reporting of Behaviour Change Interventions. Without detailed and standardised description, it becomes more challenging to draw comparisons across different studies including apparently, the same social media features. A taxonomy of social media features can certainly be used to address this issue.

With respect to a selective and unchanged set of Social Media Features being the most prevalent in interventions across behaviours and since these studies reported comparable positive outcomes, this could imply that these features are indeed suitable for a variety of health issues. However, this could also be the result of intervention designers including these features without enough consideration about their suitability and effectiveness on users for the different types of behaviours addressed and could instead, be more focussed on maximising functionalities in their interventions. Therefore, there is a strong justification to empirically test the suitability and impact of including social media features in behavioural interventions.

Three main areas were identified with regards to the effects of social media features on users, namely, usage, participants' perception and behavioural outcome. These effects can be attributed to the social influence element of these features which have been also reported in multiple research work [4, 5] which found a positive impact in sustaining behaviour change. A number of studies reported that the inclusion of social media features increased user engagement in behavioural interventions and in at least one study, higher levels of sustained user engagement through interaction with multiple social media features was reported [119]. However, when compared to face-to-face alternatives, social media features were found to produce lower levels of engagement. Among the studies which reported the perceived usefulness/ helpfulness or sense of enjoyment/satisfaction of participants when using social media features included in interventions, more than half referred to features from the Communication category, more specifically, online forums. Interestingly, in most cases participants with access to these features felt pressured and/or motivated to achieve goals contrary to the findings of Dennison et al.,[31] which reported some degree of reluctance and feeling of embarrassment when participants' data was shared among peers. However, social support originating from better performing peers did have a demotivating effect in a few studies reviewed. Although often assumed by researchers that social media features could result in lowering of attrition rate, this effect was minimal, with only one study [6], reporting an increase in likeliness for participants to complete an intervention while two other studies reported finding no such effect [36, 70]. In terms of social media features affecting behavioural outcome, our analysis found that the most effective features were Communication-based and more specifically, Asynchronous ones (e.g Online Forums). Indeed, features from this category are known to provide more direct social support which in turn can have an impact on behavioural outcome [120, 121].

The low-level of focus on privacy based on the limited amount of information provided by the studies reviewed regarding this aspect associated with the sharing and peer-viewing of

participant's data is an area which requires further attention. While privacy might not have been an issue with interventions' data accessible only to their respective users and their therapists, social media features unlock the potential of data being shared among peers. Another potential challenge of including social media features was the associated cost for moderating shared data but this was explicitly mentioned by only one study [122], which reported that moderation of the online discussion groups (online forums) was the most significant cost of their study.

2.4.1 Limitations and Strengths of the Review

Among the reviewed studies, there was a lack of information reported on the social media features included and their impact on whether the behaviours addressed were affected directly or indirectly by them. This was in-line with Michie et al.'s findings [118], which reported that behaviour change interventions with poor descriptions in their research protocols and study reports made them challenging to evaluate their effectiveness and to replicate.

Due to the fact that our review included studies from the early 2000s, the rapid evolvement of Information and Communication Technologies could introduce some inaccuracy when interpreting this reviews' finding in the current context. For example, results from the use of social media in earlier years could be differ significantly from later years due to the ways that they are used through different types of devices and interfaces. With our taxonomy however, future extensions will be possible and help researchers to gain a better under the evolvement of social media features in behavioural interventions.

This work has adopted a systematic approach for reviewing behavioural interventions which included social media features across a wide range of behaviours which has the potential to be used as a foundation for future research in the area. Along with the review, a taxonomy for categorising social media features has also been developed in parallel (See Chapter 4.).

More research needs to be carried out to find ways for isolating the effects of social media features on intervention users as this review has found that many studies do not report on these aspects clearly. The complete dataset of studies reviewed consisting of their different attributes such as Social Media Features Used, Sample Size, Behaviour(s) Addressed, etc has been available online (DOI: 10.5258/SOTON/D0274).

2.4.3 Derived Objectives

This review has found that although social media features are being widely included in behavioural interventions, little research-based evidence of their effectiveness in modifying behaviours exist. There appear to be a tendency to use these features based on convenience and

popularity rather than their suitability for specific behaviours. We have therefore derived a set of objectives that will guide the rest of the research in this thesis to help evaluate and maximise the effectiveness of social media features included in DBCIs.

1. Undertake qualitative research to gain a better understanding of the various underlying motivations and expectations of intervention builders with respect to the inclusion of SMFs in their interventions.
2. Develop a uniform and standard labelling scheme for social media features classified under a number of high level categories in the form of a taxonomy. This taxonomy could then be used by intervention builders planning to include social media features in their interventions. This will in turn facilitate future research work attempting to identify social media features included in behavioural interventions for comparison and reviewing.
3. Develop and evaluate methods for the incorporation and customisation of SMFs in DBCIs by intervention designers without extensive computer programming skills. The interventions should be capable of tracking usage data for the different SMFs.
4. Conduct further research focused on user's experience of social media features and factors such as perceived ease of use, relevance, usefulness and benefits of SMFs by participants DBCI end-users.

2.5 Chapter Conclusion

It was found that a majority of studies in this review reported positive outcomes with respect to their objectives and hypothesis. This data closely matched with that of studies reporting on the effect of social media features included and which described their positive impacts on users. The most included social media feature category across all the considered behaviours was Communication and more specifically, online forums. This was followed by social connections from the Peer Grouping category and user profiles from Identity Representation category. In terms of benefits that social media features were reported to increase usage, enhance perception levels of social support, motivation, and feeling of satisfaction and also having a direct effect in behavioural outcome. The main concerns identified with respect to the inclusion of social media features in behavioural interventions were firstly an under-reported methodical selection process based on their suitability for specific behaviours and other contextual elements. Another issue uncovered was the non-standardised way to identify and describe social media features and their effects on intervention users. And also, little information has been published

with respect to the privacy and cost issues associated with social media features inclusion in behavioural interventions.

The findings of the Systematic literature review (SLR) confirms that most of the studies which included SMFs and reported on their impact, found that that participants had a positive perception with respect to these features. Additionally, studies which only reported about their overall outcome also published positive results. Therefore, the research question "Do *behavioural interventions that integrate SMFs have positive effects on end-users?"* can be considered to have been positively addressed. The SRL has been published as part of a journal paper [132].

The review also supported the formulation of a set of objectives that would help in addressing the other research questions listed in Chapter 1. The first of which was about the undertaking of qualitative research to enhance our understanding of the motivations and expectations of intervention builders. This was carried out through a focus group study and its subsequent analysis in the next chapter (Chapter 3.). The second objective was to develop a uniform and standard labelling scheme of SMFs in the form of a taxonomy. This part of the work was performed in parallel with the reviewing process as its development was informed through the ongoing findings of the latter and is reported in Chapter 4. The next two objectives were about the development, evaluation of a method for incorporating SMFs in DBCIs by builders without requiring them to perform any computer programming tasks and further research about end-users' perception and experience about these type of SMFs. The development phases are reported in Chapter 5. and Chapter 6. while the evaluation is discussed in Chapter 7.

Chapter 3. Expectations of Intervention Builders

To determine the perceived relevance, usefulness and benefits of SMFs within different types of DBCIs, experts in the area were invited to participate in a focus group study which is reported in this chapter.

3.1 Overview

One of the objectives put forth in the previous chapter (Chapter 2.) was the undertaking of qualitative research to enhance our understanding of the motivations and expectations of intervention builders with respect to the inclusion of SMFs in DBCIs. The current chapter (Chapter 3.) addresses it by conducting a focus group study with the participation of experienced intervention builders. The detailed methodology is reported including a thematic analysis along with its results and discussions. Through this study, the findings of the SLR reported in Chapter 2. was also validated and the taxonomy of SMFs (See Chapter 4.) whose development started alongside the review also benefitted from refinements based on the results of the thematic analysis. This chapter helps us address the second research question of this thesis: "*What are the expectations of intervention builders with respect to the inclusion of SMFs in behavioural interventions?"*.

3.2 Objectives

The discussions would help explore the perceptions and needs of intervention builders with regards to the inclusion of SMFs in DBCIs. Their requirements and expectations about SMFs which could potentially be used as part of DBCIs would also be gathered.

Another aim of this work was to validate the findings of the systematic review (see Chapter 2.) and help refine a taxonomy of social media features for behavioural interventions that will be presented in Chapter 4. of this thesis.

3.3 Methodology

This section describes the research methodology adopted. This has been divided into three parts; firstly, Data Collection, describes participant selection, the focus groups setting and organisation. This is followed by a description of the procedure adopted for the focus group and finally, the details about the Data Analysis undertaken are provided.

3.3.1 Data Collection

Ethical Approval was sought and obtained from the ECS Ethics Committee - University of Southampton prior to organising the focus groups (Reference Number: ERGO/FPSE/12997).

Researchers, aged 18 years or over, having experience in the design, development and/or evaluation of digital interventions and who are working at the University of Southampton were invited to participate in the focus groups. They were emailed a short description of the focus

group topic and objectives. No tangible incentives had been provided; Instead participants were informed that they would benefit from having an insight social network features that they might plan to use in the future in their digital interventions.

The researchers who agreed to participate were provided with an information sheet, a profile questionnaire and a consent form.

Two focus groups sessions were organised and the relevant background information about the experiences of the participants in the area of digital interventions was gathered through both the profile questionnaire that they had to fill in and also, through group discussion.

Participants were informed that the focus group discussions would be recorded as audio through a smartphone placed in front of them on the table. Any participant wishing to withdraw from the discussions could do so freely. This information was communicated to participants in the information sheet. They were also verbally reminded at the start of the focus group.

3.3.2 Procedure

Participants were requested to sign a consent form, which was made available in the meeting room, before the start of the discussion. They were also requested to fill in a participant profile questionnaire. Any participant who did not wish to be recorded could inform the investigator who in turn, ensured that the recording was off while the former spoke.

The investigator started the session by welcoming all participants and thanking them for agreeing to participate. He then introduced the topic along with the focus group's aims and objectives.

Participants were informed that there was no right or wrong answers and that they should express their opinions freely.

The discussion was started with an open question asked to all the participants about their perception of social networks. This was intended to act as an ice-breaker question and get people to start talking. A semi-structured list of questions was prepared before the focus groups to help in the discussion. These questions were refined through a mock-focus group session with four postgraduate students/researchers who were not part of the real focus group study. The list of questions is shown in Figure 9.

1. What are your perceptions of social networks and social media?
2. Based on your experience, how do social media features affect interventions?
    a. What impact can their use have on :
        (i) The Interventions overall
        (ii) The participants
        (iii) The Scientists behind the interventions.
    b. Is social support beneficial for interventions? (What kind of interventions benefit the most from this?)
3. A list of social media features along with short descriptions had been circulated to you by email along with a tentative classification/categorisation scheme; We will now discuss about their usefulness within interventions;
    a. Investigator will mention one item from the list at a time and ask one or more questions from below:
        i. What are your opinions about this tool/feature?
        ii. What type of interventions do you believe it is more suited for?
        iii. Do you have any scenario in mind where this tool can be useful?
        iv. What kind of impact will the use of this feature have on the participants or the Intervention in general?
        v. Do you have in mind any modification to this feature or specialisation?
        vi. Is there any interventions that you have built which could have used this feature?

After reaching the end of the list, the investigator will ask members these questions:

4. Have we missed any interesting social element that you think will be useful for interventions?

Figure 9. List of questions used by the moderator to guide the discussion during the focus groups

The conversation with the intervention builders revolved mostly around existing social media features (SMFs) and how they could fit into their existing interventions. Their potential impact on interventions, both existing and planned ones, was also discussed. The participants also talked about the SMFs that they would more likely be interested in incorporating into their future behavioural interventions.

For each SMF, the investigator provided a brief description and invited the participants to discuss about it. They were encouraged to provide examples of usage, constraints, benefits, the relationships between different SMFs, etc.

The above was repeated with a number of SMFs while encouraging participants to contribute any other features not mentioned by the investigator.

At the end of the discussions, a summary was presented by the investigator and the participants were provided with a debriefing sheet along with an email address to contact for more information.

3.3.3 Data Analysis

The audio-recordings of the focus groups discussion were transcribed verbatim and printed for the initial phases of data analysis.

In order to identify recurring patterns and themes from the data, the approach for inductive thematic analysis proposed by Braun and Clarke [123] was used. The data was then codified. The codes and corresponding labels are provided in Appendix B.

3.4 Results and Discussions

Eight researchers initially agreed to participate. Due to the busy schedule of the participants, two focus groups consisting of four (three female and one male) and two members (all female) were organised. While the other two potential participants had to withdraw as the timing for either focus groups did not suit them.

The transcription of the audio-recordings for the focus groups discussion yielded 40 pages of text which after being codified, led to the identification of a total of thirty codes; fourteen were classified as main codes along with sixteen sub-codes which were mainly used for flagging Social Networking Features (See Appendix B).

While the intervention builders believed that it was a good idea in principle to use SMFs DBCIs, there was an overall scepticism about the lack of control in an otherwise, tightly-controlled environment geared towards maximising the effectiveness of these interventions while reducing external interferences as far as possible.

The different themes identified were:

1. Sensitivity towards the inclusion of social media in DBCIs
2. Social support
3. Social sharing
4. Social Media Features (SMFs)

These themes are discussed along with relevant quotes from the focus groups participants. The terms intervention builder(s) and/or participant(s) in the discussions are used to identify the

intervention builders(s) who participated in the focus groups and the terms 'end-users(s)' correspond to digital intervention end-users.

Theme 1: Sensitivity towards the inclusion of social media in DBCIs

All the participants believed that it was a good idea in principle to use social media features in DBCIs. However, their enthusiasm quickly turned into scepticism when they started discussing about the lack of control that would be introduced by social elements in an otherwise, tightly-controlled environment geared towards maximising the effectiveness of these interventions while reducing external interferences as far as possible. This perception was mostly based from the fact that the intervention builders had the tendency to think about two popular OSNs (Facebook and Twitter) when asked about social media and thus voicing out their opinions with comments such as:

> *"It's the first thing I thought of as well. Facebook and Twitter, although we don't use them very much." (F2P2)*

A more positive attitude was demonstrated after clarifications were given about the emphasis being on the concepts of social media features in general rather than specific online social networks. In fact, should SMFs be fully integrated within interventions and their associated data stored locally, this would address most of the concerns raised by the intervention builders which could be interpreted from the comment made by one of them:

> *"In an ideal world it would be preferable to have it (Social Media Feature) contained within interventions, not on a Facebook-like thing or a Twitter-like thing." (F1P2)*

Indeed, the most recurring pattern during the discussions was about the importance for control by both the digital intervention experts and the end-users. With respect to control exerted by the former, a participant said:

> *"I think my main concern would be the lack of control you have over other people's responses." (F1P2)*

One way to counter this issue, would be for the intervention experts to assign one or more people to a monitor and/or act as moderator(s). However, one of the main motivations behind the use of DBCIs in contrast to more traditional 'offline' interventions was the low-cost factor for deploying and running them as mentioned by one intervention builder:

> *"Digital interventions are cheap to implement but cost will rise in case constant monitoring will be required." (F1P1)*

Theme 2: Social support

One of the main benefits of using SMFs in DBCIs according to previous studies [14, 107, 124] has been their social support aspects that were described as beneficial to intervention end-users who would feel that they were being cared for and would receive assistance from a supportive social network. Intervention builders were unanimously positive about it being beneficial. However, their main concern was that it was difficult for them to implement:

> *"I actually think it could because I think one thing is very difficult to harness in digital interventions is social support." (F1P3)*

The main challenge for them being able to integrate social support into their intervention was the financial cost associated with the provision of support to end-users by employing specialised personnel. This can be understood from the following quote:

> *"…the interventions where you have support or a health code or some kind of human contact do a lot better generally than just the intervention on its own…umm but it's more expensive. So we don't really do that because they are cost-effective which is more important. But if you could get it in a way that you could provide (it), that would be great." (F1P2)*

Providing social support through the use of SMFs could help overcome the cost-related barrier and enable people with psychological conditions and who may not have much social contact to benefit the most as was mentioned by one of the intervention builders.

Although there are opportunities for providing social support through the use of SMFs, it was considered important that intervention end-users be empowered in being able to choose from whom and when to receive it. An example provided by an intervention builder was an NHS Quit Smoking Programme was:

> *"They have a feature where you could have umm official supporters that you could nominate."(F1P2)*

In fact, giving end-users control over who can have access to their personal data is an important aspect as in some cases, It was felt that end-users would prefer anonymity over receiving support from existing friends according to the participants:

> *"Lot of people think it's a bit embarrassing thing, they want to do something on a computer or on a phone because no one has to see them." (F1P2)*

> *"It kind of counteract another ummm [sic] advantage to digital interventions which is the possibility of being anonymous." (F1P4)*

Enabling end-users to choose from whom to receive support would also enable them to identify people that they can trust. In case, there are experts also involved in providing the social support, this feeling of trust would be further re-enforced.

Another aspect that would need to be considered would be to determine when would be the most appropriate time for providing that kind of support. Enabling end-users to indicate their preferences could be considered.

Receiving social support through SMFs could be categorised into two main forms which are suitable in varying contexts and which might also have potential pitfalls. Firstly, targeted social support would include end-users receiving personalised messages from either other end-users, the intervention system or experts (e.g nurses) and secondly, generalised social support which would include for example situations where an intervention end-user would get access to other end-users' data which they could use for comparison with their own performances.

Targeted social support would be the most straight-forward in the sense that it could be provided by anybody to the end-users through personalised messages. As discussed by the intervention builders, enabling end-users to communicate with one another could motivate them as suggested by the following quote*:*

> *"I think with that example dieting support from other people..tell them[sic], struggling, motivate each other." (F2P1)*

End-users could also benefit from feedback about their progress from others in the form of comments. But in these situations, the reliability of the feedback could be an issue according to the intervention builders.

There are multiple ways to overcome it; each with its own implications. One way would be to enable only experts (e.g nurses) to provide feedback; or moderation of all feedback by experts. These two solutions could however prove to be costly and financially prohibitive for large interventions. Another option would be to allow supporters to publish non-textual feedback such as 'thumbs-up' or Facebook-style 'Likes' as suggested by intervention builders in the following quotes:

> *"You could have different responses just like the thumbs up." (F1P2)*

> *"Have three positive options- random participant like like like." (F1P4)*

More generalised forms of social support which could also be considered as indirect social support would involve an intervention end-user accessing other end-users' data to get ideas or compare with their own progress which could help them feel motivated. This kind of

comparative data could also be aggregated, enhanced with generalised feedback by experts and provided to end-users in the form of social notifications. This could motivate them to remain engaged and undertake specific activities. Examples of scenarios described during the discussions included:

> *"… 60% of people have completed whatever the task was. Tied to a specific A useful sort of motivator. Personal I guess. It could be useful for motivating people." (F2P1)*

> *"…80% have completed; I'd be more willing to do it."(F2P2)*

Theme 3: Social sharing

This theme discusses data sharing undertaken either directly by intervention end-users or indirectly, through data aggregation of multiple end-users by interventions.

One of the main points that the intervention builders emphasized during the discussions was about the possible reluctance of some intervention end-users to share their data with others. While this would vary between individuals, it would also depend on the type of intervention and type of data being dealt with. An example given during the discussions was about mental health-related interventions:

> *"…we deal with psychologists but if we are talking about mental health then it that's even less likely that they will want to share their data. Depression Anxiety and whatever disorder I think that's even more private…"(F1P2)*

The importance of empowering intervention end-users by giving them the choice of what to share and with whom were repeatedly raised by the participants. Providing these options to end-users might encourage them to share some of their data with selected people rather than sharing no data at all. One example given was the provision of a 'Share' button next to end-users' data items:

> *"I think it is useful to have the option because some people would want to post it to their Facebook walls." (F1P2)*

However, once published on public social networks like Facebook, any subsequent feedback received about the published information originating from Facebook would not be considered as part of the intervention due to the lack of control.

Depending on the level of freedom for sharing data and communicating among themselves provided to intervention end-users, there would be the associated risk of unreliable information being shared. Therefore, there would need to be some level of oversight by interventions

experts over shared data especially in group communications. Moderation was suggested by at least two participants:

> *"...you know making sure the content is good, for controlling the trial and not having any variable." (F1P3)*

> *"Just a basic of having the duty of care of participants...the responsibility that people won't come to harm." (F1P2)*

We believe that this would ensure the reliability of the shared information, controlling trials while avoiding unnecessary variables but also for ensuring end-users' health and safety are protected. As an alternative, it was proposed that direct interaction among end-users could be replaced with data collected by interventions from multiple end-users, aggregated and the resulting information could then be shared with end-users. Currently most interventions already gather data from their end-users but do not usually share aggregated data with them:

> *"Yeah..how much weight you have lost..yeah yes we all do that..but we don't share it between the participants."(F1P2)*

Nevertheless, the aggregation process could be automated mostly for quantitative data while the more qualitative types could be batch-moderated by experts.

The main benefit that intervention end-users would be expected to reap through the sharing of their data is social support from other end-users as well as from the intervention experts. With that benefit in sight, it would be expected that end-users' reluctance in sharing data could be mitigated. Furthermore, some people are more naturally inclined to sharing with the intention that whatever they would share could benefit others as suggested by an intervention builder:

> *"It's a good way of sharing what you think with other people and people can learn from you as well." (F2P1)*

The intervention experts might also benefit from having SMFs in their interventions in situations where end-users would share their data on public social networks along with embedded links pointing to information about the interventions. Therefore, sharing by end-users could in some cases help in spreading information about interventions and increase the recruitment of potential end-users.

Theme 4: Adequacy of Social Media Features (SMFs)

This theme groups the SMFs discussed with a focus on their perceived usefulness in DBCIs, potential issues and concerns as voiced by the intervention builders.

Feeds, Notifications and Reminders

The Intervention builders all expressed that notifications and reminders were often used in their interventions and considered these as being useful:

> *"They are definitely useful. Yeah cause [sic] it's so easy to forget to do something." (F2P1)*

> *"We do, a lot of interventions already have the reminder so umm [sic] emails…participants or so that is something and again some people find that really useful as reminders because they say: oh without that I would forget." (F1P1)*

However, it was already found that care should be taken to avoid over-using notifications and reminders as the participants were quoted saying:

> *"Other people find that really irritating, cause[sic] they don't like being sort of bombarded with all sorts of messages and emails or whatever." (F1P1)*

> *"As long as they're not used too much - when you get too many reminders to ignore them. Leave them, not pay too much attention to them." (F2P1)*

Therefore, it is important to empower end-users with the ability to determine whether and when to receive these notifications and reminders as evidenced in the following quote:

> *"I think the main thing is you know kind of empowering people to be in control of the intervention- that is one of the main things we try to do. So, with notifications and reminders, giving people the option to turn it off or to choose when they receive it things like that." (F1P2)*

There are indeed perceived benefits for a particular end-user in receiving notifications about other end-users. These could be for example, getting a motivating feeling or gaining ideas. There were suggestions to link notifications to other form of social networking features, for example, aggregated results from polls could be used as notifications to encourage end-users in undertaking particular tasks as an intervention builder described:

> *"I can't think of the exact details - 60% of people have completed whatever the task was. Tied to a specific useful sort of motivator. Personal I guess. It could be useful for motivating people." (F2P1)*

In terms of feeds, which could enable end-users to view notification items with some customisation possibilities in a listed format, again, intervention builders did not provide end-users with information about others. The main mode for providing feeds for intervention end-users had been through email. The expectation that end-users should be able to control and

customise the feeds was raised again for feeds. When asked if social feeds would be useful, one intervention builder said:

> *"Yes, that's like switching on your buddies…so it's people [sic] choose it, (if) they want to choose it" (F1P3)*

Informal Knowledge Repositories (e.g. Online forums)

All the participants said that they were already using some basic form of informal knowledge repository for providing factual information to end-users but that there was no input from end-users, unlike the socially-enhance knowledge repository which in its basic version could be in the form of an online forum. This could potentially be explained due to the fact that setting up such a feature within interventions would require extensive technical skills outside the area of most intervention builders. Initially there were some scepticism about using socially-enhanced Knowledge Repositories:

> *" I'm not sure about the knowledge repository (laughs) in terms of sharing what participants (end-users) have read because what people have access to is not necessarily good information and it's not necessarily scientifically sound or proven." (F1P2)*

There were concerns for cases where end-users would be contributing resources to the repository. Therefore, some form of control and vetting would be important for cultivating trust among end-users in comparable ways to real-life 'nurse-patient' interactions as a participant implied:

> *"…you know that if there is a nurse there as well…you could sort of trust…". (F1P4)*

They were told how a socially-enhanced knowledge repository could track the access patterns of end-users and create trending list of topics/items as well as the possibility for incorporating some recommendation system alongside. Several participants voiced their strong desire for having such a feature in the generic framework. A few comments made in that respect were:

> *"You know I really like that idea and in fact it would be amazing if you could build that into the <name removed> software." (F1P2)*

> *"…it's amazing umm- and yeah it would be good to share-you know what are the most common, you know like trending." (F1P3)*

There were also some suggestions given to further improve the feature such as structuring information in a question-answer style, including search capabilities etc. Indeed, socially enhanced knowledge repository is a feature that the intervention builders demonstrated

enthusiasm for using in future interventions as it would be an evolution from their current basic information-providing mechanisms within digital interventions.

Leader Boards / Ranking Tables

Providing intervention end-users with a list of all end-users including themselves sorted in terms of achievements could be beneficial in a rather limited set of interventions. Behavioural interventions dealing with physical activities which would already be of a competitive nature would be the most suited for using leader boards. A participant was quoted saying:

> *"I think it might depend on situation on the condition and the context and I wonder if umm if [sic] actually see about how people feel about it. Because I think I would quite like to know that I've done like so much physical this week, surely I've got to be near the top. But then actually I haven't abandoned and 50 minutes physical activity isn't a lot, you know." (F1P2)*

And it was argued that maintaining end-users' engagement with such a feature would be difficult over long periods of time as suggested by another participant:

> *"You can do it in a short term three weeks or so, just to maintain that, maintain the long-term [sic], it does not seem very maintainable cause [sic] you just do that and always to be thinking I'm gonna [sic] be at bottom this week…not sustainable…" (F1P4)*

Another participant added that in case an end-user found himself/herself repeatedly at the bottom of the list, this could prove to be discouraging:

> *"They see that they are below someone, they give up, it's that competitive nature." (F1P1)*

Therefore, while it is good to have the option, more qualitative research will have to be undertaken. This can help determine whether SMFs are truly beneficial for behavioural intervention having a competitive nature-only and also, the optimal duration that it should be used to maximise any benefits.

Self-Reporting & Progress Viewing Tools

Self-reporting tools were described as features enabling end-users to input different measures into an intervention and the data would then be shared to others automatically. Although the participants said that they were already using some form of self-reporting tools but without any sharing among end-users, they expressed their reservations with respect to the automated sharing concept and preferred an approach where end-users are given the choice about different aspects of sharing. But it can be expected that at least some end-users may be more open to share their data on public social networks.

While the data collected through these self-reporting tools would be used by intervention experts and researchers, the end-users could also benefit from it by being able to view their own progress which could be further enhanced visually through the use of graphs:

> *"They can view themselves, so each person would get a graph or something…(to see) their progress." (F1P2)*

This could lead to linking self-reporting tools and progress viewing as mentioned by a participant:

> *"…self reporting tools may be useful because they are related to progress viewing." (F2P2)*

In turn, the progress viewing could be used by an end-user to compare his/her own performance with an average reference calculated through aggregated data from other end-users:

> *"Sort of like an average of how a group is doing…someone else's current weight and build that kind of stuff." (F2P1)*

A step further to enhance the progress viewing feature would be to link the end-users' data with the activities that they undertook:

> *"But if you could like link someone's…[sic] like someone's mood response and then link that with that activity you know and doing lots of activities and feeling really good and you know gradually getting thinner. Umm then that might work." (F1P3)*

Based on the discussions, it is likely that having socially-enhanced self-reporting and progress viewing tools as SMFs within behavioural interventions could be beneficial to end-users although, this will depend on the type of data being collected and will require trialling with users. For example, the input of quantitative data can be more easily automated and displayed graphically compared to qualitative data.

Challenges and Goal Setting

While features such as challenges and goal setting were common in interventions, there was no social-aspect associated to them. Therefore, the end-users could see only their own data when using them. The main argument justifying this was the lack of relevant technologies for socially enhancing the features as suggested by an intervention builder:

> *"We have a two week challenge in the --trial but it's not linked to any sort of social media but I think it would be good if we have the technology to do it…" (F1P2)*

Intervention builders that integrated challenges and goal setting features into their interventions suggested that these should be made optional for end-users to use and should not last over a long period of time as emphasized by a participant:

> *"So it's very short, we have an intervention for about six months in total but for two weeks [sic] we couldn't fit a two weeks challenge and it's optional, you can even choose whether you want to take part or not. And then we basically return them to [sic]." (F1P2)*

One participant voiced her concern regarding the perceived and possibly unwanted feeling of rivalry that might be introduced if end-users were allowed to suggest any other end-user to take on a specific challenge:

> *"…because it's the rivalry I don't think we could match people in, it's not comparable.it would be good if you could match..you know. " (F1P3)*

It would be more suitable for end-users having appropriate and comparable conditions or properties to be able to make those suggestions. To which one participant added that these features could be linked to social groups:

> *"Yeah and I think…yeah in conjunction with groups" (F1P3)*

Indeed, social groups could be formed with individuals who have certain common attributes and therefore be more comparable. Another aspect discussed in relation to socially-enhanced challenges and goal setting features was the way information would be shared with an example given by a participant:

> *"It will be helpful not to say (Person X's) goal is not to eat cheese this week but to say Ingrid met her goals" (F1P2)*

That is, the information shared should not be considered as over-intrusive to end-users while at the same time, it should not be a cause for embarrassment for example, when challenges or goals are not achieved.

Diaries & planners

According to the intervention builders, diaries and planners were commonly being used as part of DBCIs. By their very nature, the data that the end-users filled in would be accessible only to himself/herself and to the intervention experts. They all agreed that there could be some positive impact if they were shared among peers such as end-users getting helpful ideas from others in the same situations as themselves as described in the following quoted examples:

> *"I think if people had the ability to see someone else's diary from the previous week and where they see what they did and link that to so they can see-person … then that might be quite useful- people would be able to see umm the other way round I suppose and then they could look back and see what actually was…" (F1P1)*

> *"People like it to be quite tailored to be like this being able to see individual users' diets..give you ideas..it would be quite interesting for others." (F1P3)*

They also mentioned various issues associated with giving end-users access to others' data as discussed under the Social Sharing theme. The concerns with respect to end-users' privacy when access to their diaries and planners is indeed founded and should be carefully looked into. In fact this should be addressed alongside all other SMFs and the context in which they are being used.

Questionnaire, Social quizzes & Polls

Conventional questionnaires were said to be already prevalent in DBCIs where they were used to gather data from end-users. For example, before starting to use different features of an intervention, a base-line questionnaire would be used to collect demographic along with other relevant information from end-users. However, in most cases the data was made available only to the intervention experts. When the intervention builders were asked about socially-enhanced questionnaires and their derivatives like social quizzes and polls, which would enable end-users to see each other's answers (e.g. a participant would be able to search for other participants having the same age), they all enthusiastically voiced their belief that these would be beneficial in DBCIs with comments such as:

> *"I think polls will be brilliant." (F1P2)*

However, instead of merely sharing raw answers, they suggested that the answers be aggregated into percentages. This could be interpreted from the following quoted example from a participant:

> *"60% of people have completed whatever the task was." (F2P1)*

This could be used to encourage end-users to undertake a task that they did not attempt. Another example was:

> *"Like 75 % of the people also struggle with breakfast every morning." (F1P3)*

In this case, end-users' engagement could be promoted through motivation as they would realise that they were not the only ones struggling. If the situation was to be reversed whereby

end-users would ask questions to intervention experts or even to other end-users; this was not a common feature used in DBCIs. Anonymising the identity of the end-users asking the questions was perceived as a way to encourage them to come forward.

But enabling end-users to answer questions asked by other fellow end-users would expose risks as discussed in the Social Support theme.

Social Groups

Based on the personal experiences of the intervention builders, they had all used some form of groupings in their interventions but had not used social groups where end-users would be able to communicate with one another.

> *"So you know some people could be in a group where they get support but they don't know each other in that group. That's part of…you know, a clinical trial methodology."(F1P1)*

It was argued that such groups could work for DBCIs provided that some conditions be present such as the groups having a supportive effect on the end-users and that the interventions' context be appropriate as said in the following quotes:

> *"So if you gonna [sic] have something…some groups thing; It would have to be a supportive group, a nice group, a help each other group, it's ok…" (F1P1)*

> *"I think for some conditions and some things, that could be helpful". (F1P2)*

Based on the arguments put forward by the intervention builders, it can be interpreted that they all believed social groups could have a positive effect on end-users. One such comment was:

> *"Potentially yeah…one way I guess..,learn a particular behaviour [sic]..umm then you have other people to talk to about it and to see how they are doing and learn..I think it would be useful..groups settings as well." (F2P1)*

The perceived benefits of such groups according to the intervention builders, would be to enhance the end-users' engagement and as a result would lead to lower attrition rate as discussed in the Social Support theme. A participant mentioned that the outcomes from forums could be similar to groups:

> *" if you did sort of forums, some sort of areas where people could discuss the symptoms..people getting frustrated; frustrated and not wanting to use the intervention." (F1P1)*

It was implied that the frustrations could be attenuated and the end-users would feel encouraged to remain engaged with the interventions. Supportive social groups would be more beneficial in behavioural interventions which target conditions that the end-users have developed and been diagnosed at later stages of their lives rather than conditions that they would have been born with. An elaborate example given by a participant was as follows:

> *"Because for things like [sic], there's a difference between a condition that you live with, you have (during) your entire life; suppose you're an adult, you (are) probably used to managing to some degree, whether good or not and living with it. Something you're diagnosed with (later in life) , like a terrible illness like multiple celerosis, or cancer,or COPD these things generally have support groups that are really helpful that people do and that really exists." (F1P2)*

An important aspect when using social groups in DBCIs would be their formation. This process could be either automated, manual or a hybrid of both. In the automated mode, end-users could either be assigned to groups at random by the system which the intervention builders had been already doing in conventional groups or assignment of group members could be done by the system based on certain properties, demographic data or stage of treatment of the participants. In manual mode, assignment of end-users to specific groups could be determined by the interventions' experts based on their research objectives and the type of interactions they would like to observe. The intervention end-users could also be given the freedom to choose which group they would like to join or create their own groups and therefore self-categorise themselves. The hybrid mode could be more beneficial for research purposes where groups are initially formed either automatically or manually and then sub-groups are created with the other mode to provide some kind of control groups usually used in clinical trials.

One issue that the intervention builders were particular concerned about was the health and safety risks along with the associated legal issues for assigning interventions end-users who might already be in vulnerable states to groups that might be composed of dangerous individuals whom the interventions experts might not be aware about. This was mentioned in the following quotes:

> *"You know..I don't know about safety concerns and legal issues around that." (F1P1)*

> *"People wouldn't want to take the responsibility for setting up (a) serial killer." (F1P2)*

However, the use of groups could introduce other issues which were discussed in the Social Sharing theme. Other SMFs such as polls, question posting etc, could in fact be embedded within groups which as a result, will bring along all their associated implications to groups.

User profiles

The important aspects raised for user profiles were mostly about the kind of information that a profile would contain and the level of control that each end-user would have over the data being shared. Some data including photos could be uploaded by the end-users as was suggested by a participant:

> *"When they create their profile, (it is) necessary (to) have your [sic] photo..(they) have the option of setting the information and then it is useful for other people to be able to see the information as well." (F2P1)*

Other information could be automatically uploaded using data gathered through an intervention's baseline questionnaires as proposed by another participant. Indeed, it is believed that this could help monitor the end-users' progress. One piece of information that would often be used in user profiles would be photos. However, due to the necessity for maintaining end-users' anonymity for some interventions, an intervention builder proposed the use of adaptive avatars:

> *"The best thing about profile possible creating some kind of avatar.. because that is completely within your control and then that could be used in different features of..of [sic] everything and you could invent; you could choose your avatar." (F1P1)*

Although, other participants agreed that avatars could be helpful in user profiles, the way that they were proposed to be used did not qualify this feature as an SMF in itself but rather, a type of information primarily used by single end-users.

It was agreed that user profiles could be used to host other SMFs and thereby act as a kind of container for them. Therefore, although it was viewed as useful, this was more as a supporting role for other SMFs.

3.4.1 Summary of Key Findings

While all the intervention builders were enthusiastic about including SMFs within their future interventions, most of them initially expressed their concerns about the perceived limited control when incorporating these features. According to them, unvetted information along with the lack of privacy protection could have detrimental effects on the outcome of the interventions. But if the appropriate mechanisms are put in place to tackle these issues, they would be positive in incorporating the SMFs.

There was a unanimous agreement among the intervention builders that the potential of SMFs in facilitating social support in behaviour change interventions will be beneficial but this type of support might not always be appropriate for certain types of interventions, such as those where anonymity is important.

Similarly, while data sharing among intervention participants might have a positive impact on them, privacy concerns must be managed by for example providing them the capability to decide on different sharing options.

Although the builders knew about most of the SMFs discussed during the focus group study, they mentioned that they had not tried them within their past interventions as they found them difficult to integrate mostly because of a lack of technical skills required. However, they welcomed opportunities to test the SMFs in their future interventions if they are given the necessary capabilities to incorporate the features. Two SMFs they would appreciate the most to start experimenting with were polls and social knowledge repositories (forums).

3.5 Chapter Conclusion

The strengths, limitation, ethical issues as well as the findings of this study are described in the following subsections.

3.5.1 Strengths, Limitations and Ethical Issues

The focus group study enabled a guided discussion on the usefulness of different social media features (SMFs) for different types of digital interventions, providing rich data about SMFs requirements and experts' expectation towards them in Digital Interventions. The group discussion ensured that the risk of overlooking a particular feature is minimised.

Although the participants were among the leading experts in the area of digital interventions design and authoring, several among them already knew one another and this might have affected how they express their views. However, based on the fact that the main topic of discussion was not a sensitive one, the issues raised was not expected to affect the outcome of the study.

3.5.2 Reflections and Findings

Since different SMFs' suitability varied from intervention to intervention, the discussions were guided so as to find out which SMFs were perceived to be the most useful and would more likely be utilised in the intervention builders' future interventions in the short term if made available through the generic framework. Therefore, it is worth noting that the intervention builders gave their personal opinions which might not be evidence or theory-based.

Based on the discussions about each SMFs, 'polls', which enabled aggregated data of end-users to be shared were perceived among the most desirable feature that the participants were enthusiastically willing to use in their future interventions. This was followed closely by socially-enhanced knowledge repositories which commonly takes the form of online forums that most participants showed strong interests and believed them to be beneficial to end-users. Another feature that was suggested during the discussion and which dominated discussions on several occasions was the use of adaptive avatars within user profiles which would replace participants' own profile photos. However, all the intervention builders who participated in the focus groups agreed that the different SMFs could all potentially be beneficial within DBCIs but would need to be tested first as suggested by one of the participants.

This study helped towards understanding intervention builders' perception of SMFs in DBCIs. They showed strong interests in two SMFs (Polls and Socially-enhanced knowledge repositories (forums)) that were presented to them and a third, 'Avatars', that one of the participant proposed.

This chapter successfully addresses the research question "*What are the expectations of intervention builders with respect to the inclusion of SMFs in behavioural interventions?".* The thematic analysis enabled the identification of four themes namely, (i) Sensitivity towards the inclusion of social media in DBCIs; (ii) Social support; (iii) Social sharing; and (iv) Social Media Features (SMFs). The intervention builders who participated in the focus group study all agreed that SMFs could potentially be beneficial within behavioural interventions and were all willing to include them in their interventions provided that some issues associated with these features are addressed. These were firstly the ability to incorporate SMFs in DBCIs without requiring advanced technical skills. The lack of control and the ability to safeguard the privacy of participants were also of concern to them. Based on this, a web-based intervention authoring tool was developed as reported in Chapter 6. which enables intervention builders to add SMFs to interventions through a graphical user interface without requiring any computer programming skills. The concerns of the builders were also taken onboard during the authoring tool's development to enable customisation of the SMFs with respect to privacy. The analysis also revealed that the two most desirable SMFs to the intervention builders for experimenting were polls and a Socially-enhanced knowledge repositories (forums). One of these two features, the poll, has been used as part of a pilot experiment (See Chapter 5.) and both features were used in a subsequent, final experiment (See Chapter 6.)

Chapter 4. A Taxonomy of Social Media Features

This chapter presents a taxonomy of social media features and describes the motivation behind the development of a taxonomy to inform the construction of behavioural interventions.

4.1 Overview

As discussed in Chapter 1., the lack of standardisation among DBCIs hinders cross-studies evaluations and this led to the formulation of the research question "*How can SMFs be organised so as to standardise, facilitate and guide their inclusion in behavioural interventions?"*. The issue was also confirmed during literature review in Chapter 2. The current chapter looks into the development of a taxonomy of SMFs to address this aspect of the research. A first version of the taxonomy was created based on initial literature review which was then completely reworked based on the results of the focus group study (See Chapter 3.) and on the SLR findings reported in Chapter 2 to produce a finalised version of the taxonomy.

4.2 Motivation

Based on our systematic review, it was found that the lack of a taxonomy to describe and guide the use of SMFs in DBCIs resulted in the development of interventions that make cross-studies' comparison difficult due to a lack of standardised approaches and methods. This could potentially lead to inaccuracies in the reported finding of those comparisons. It was also found that intervention builders included SMFs with varying degree of awareness of their impact on end-users in different contexts. At present, there is no published scheme for the organisation and categorisation of social media features intended for inclusion in behavioural interventions. A taxonomy of social media features aimed at intervention designers and researchers will therefore enable the development of guidance to the selection and inclusion of the most effective features in interventions addressing specific behaviours.

4.3 Taxonomy Development

The development of the taxonomy was conducted in two phases with the first phase relying on a preliminary literature review. The taxonomy that resulted from this phase was then refined based on the analysis of the Focus group study (See Chapter 3.) and the Systematic Literature Review (See Chapter 2.) and this final version is presented in phase 2.

4.3.1 Phase 1: Taxonomy Based on Preliminary Literature Review

This first version of the taxonomy of social media features was made based on a preliminary literature review. Potential SMFs that were identified and used in the taxonomy are shown in Table 6. A 'Traditional Use' column describes how these features are commonly used in

behavioural interventions as stand-alone and without the possibility for data sharing or communication among users. The 'Socially-Enhance' column describes the possibilities to extend each of the features with some social elements.

Feature	Traditional Use	Socially-Enhanced
SMFs Having Predominantly Informative Characteristics		
Feeds	Provide information sorted chronologically about activities happening within an intervention related to the end-user.	Allow end-users to receive feed updates about activities undertaken by other end-users from same group for example or information based on aggregated data from others.[36, 111, 113]
Knowledge Repositories	Knowledge repositories or information pages in DBCIs are often static information which end-users can browse and read.[7, 119]	End-users can explicitly share information that they find useful in the knowledge repository on their social networks or to specific friends. Moreover, information about articles that are among the most popular (based on aggregated data from all end-users are provided in the form of trends. This is further enhanced through recommendation systems that compare patterns in information accessed by end-users to make suggestions. A simplified version of a socially-enhanced knowledge repository can be in the form of an online forum.
Leader Boards/ Ranking Table	While traditional Ranking tables/ Leader boards use data from other end-users, they can only be viewed.	End-users are able to comment on their friends' and their own progression as well as share their achievements to OSNs and friends.[111]
Notifications & Reminders	End-users receive notifications and reminders about their own activities only.	End-users receive notification about activities performed by other end-users from their group for example. Users can send reminders to each other with motivational messages to encourage them to undertake specific activities.[53, 111]
Progress Viewing Tools (Graphical)	End-users can view their progress over time through graphs. An example would be in a physical activity enhancement DBCI.[7]	As well as viewing their own progress over time, end-users can view the progress of others who have chosen to make their data available. They can then comment on each other's performance, providing advice and support.[116]
SMFs Used Mostly for Data Entry		
Challenges and Goal Setting	End-users set their own goals and choose challenges that they want to take. The information is shared only with the intervention experts	Information about goals set and challenges taken are shared with other end-users who can comment and provide support, tips etc.[7, 14]
Diaries/ Planners	End-users document their thoughts and plans. The data is made available to themselves and to intervention experts. Only an end-user can edit his/her data	In addition to the documenting their own information, end-users have the ability to share some information to others on OSNs. They can receive feedback as the shared information can be commented on by others. Similarly, they can view other end-users' shared diary/planner entries to get ideas for example getting ideas from someone' 'Meal Planner' [36].
Self-Reporting Tools	End-users input data manually into the system which is then forwarded to intervention experts for follow-up.	Additionally, the tools can be enhanced to gather data from OSNs such as interactions and activities carried out and also the data to be shared with other end-users who can provide feedback through comments.[107, 119]
SMFs Having Both Informative and Data Entry Characteristics		
Groups / Message Board	Groups are used in most DBCIs to categorised end-users; for example, one group doing an intervention with expert support available and a control group with no such support. However, end-users cannot communicate among each other.	Groups used as a platform for communication which can be compared to some extent to Message Boards [6, 119] but with much richer interactions occurring. Some groups can be created by end-users themselves, for example, in rival nomination (a group of two end-users), an end-user nominates another person to share information[107]. Other SMFs can also be embedded within groups.[14, 125]

Polls	End-users vote for items set by intervention experts and data is made available only to the experts.	Polls can be created by either intervention experts or end-users. Aggregated results for all end-users are presented to them in the form of charts. End-users can add comments for others to view. Poll Results can be shared on public OSNs.
Questionnaires	These are used to gather data from end-users. For example, baseline questionnaires could be used to gather information about gender, age, education level etc and this is all sent to the intervention experts while the end-users do not have access to the data.[113, 125]	The data gathered through the questionnaires are made accessible to the end-users in aggregated form. An example would be a Social Quiz whereby end-users answering a quiz-style questionnaire receive customised feedback at the end which compares their results to an average performance obtained by aggregating the results of other end-users.[36, 53]
Question Posting	End-users ask questions or request for support either on phone, SMS or via email to intervention experts. [126]	Questions can be asked by end-users anonymously and which may be visible to other end-users who can then contribute to the experts' answers following proper vetting.[36]
User profiles	Some DBCIs have a private profile containing very basic information about an end-user and which remains accessible only to that user and to the intervention experts.	Provides the option to make profile visible to others, publish information for others to see and allow others to share information on one another's profile. Other SMFs can also be embedded within user profiles.[14, 36]

Table 6. Potential Social Media Features for Behavioural Interventions

This first version of the taxonomy for classifying SMFs for behavioural interventions was based on their roles and main attributes and is shown in Figure 10.

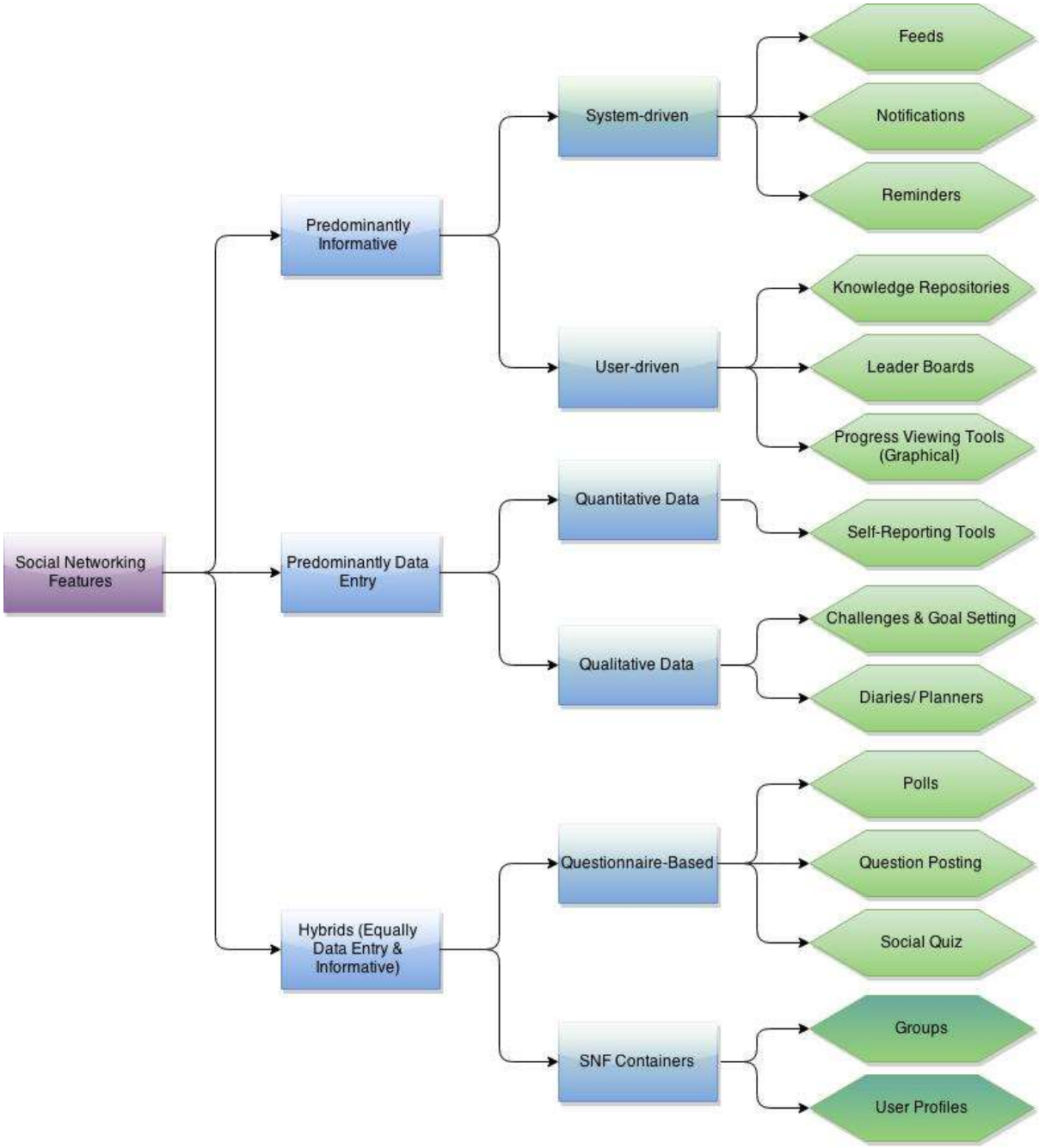


Figure 10. Taxonomy of SMFs for Behavioural Interventions (First Attempt).

SMFs can be classified intro three main categories as shown in Figure 10. namely, those having a predominantly informative role, a second group consists of those having a mostly data entry role and finally, SMFs having balanced roles between informative and data entry which are referred to as hybrids in the taxonomy. However, it should be noted that the first two categories mentioned are not mutually exclusive as SMFs having a mostly informative role can have a certain element of data entry as well and vice versa but at a lesser extent.

SMFs under the 'Predominantly Informative' group consists of those which are used for providing information to end-users in a behavioural information. These SMFs can be subdivided into two categories. Firstly, 'System-driven', where the behavioural intervention automatically provides information to end-users without the latter having to actively seek it. The information provided is usually tailored to individual end-users' needs. Examples of SMFs falling under this sub-category includes feeds, reminders and notifications. On the other hand, features that require end-users to take certain actions every time that they wish to access some information fall under the 'User-driven' sub-category with SMFs like progress viewing tools (graphical), leader boards and knowledge repositories as examples.

The second main category, 'Predominantly Data-Entry' consists of SMFs which can be classified firstly as being mostly 'Quantitative data'-based and having measures such as weight, duration of certain physical activities etc and which usually make use of devices such as step-counters, weighing scales and other sensors including those on smartphones to record measures that are then input into the intervention's system through the SMFs referred to as 'Self-Reporting Tools'. And the other sub-category, 'Qualitative data', groups SMFS which relies mostly on end-users entering most the information manually such as in a diaries/planners and challenges and goal settings SMFs.

The third category is a hybrid grouping of SMFs where there is some kind of balance in their attributes falling under the first two categories that is, SMFs having both informative and data entry roles. Several SMFs under this category have been found to be some kind of specialised sub-class of questionnaires from which they derive their data entry role and their specialisation mostly forms part of their informative role. Examples include 'Polls' which use questionnaire for capturing end-users' choices and present the aggregated results in textual (tables) and graphical (charts) forms. Other SMFs which are sub-classes of questionnaires are Social Quizzes and Question Posting. User profiles and groups on the other hand are SMFs that are usually used to embed other SMFs as sub-components and are thus grouped under the sub-category 'SMF Containers' and as a result they can both have extensive informative and data-entry roles derived from the SMFs embedded into them. For example, on their user-profiles, end-users may use questionnaires to enter data about themselves, undertake a poll and publish the results for others visiting their profiles to see etc. As for groups, end-users may use a 'Question Posting' SMF to ask a question to other group members, view the progress of all members through progress viewing tools etc.

This first version of the taxonomy was used as one of the Focus Group Study aids (See Chapter 3.) to promote discussion and subsequently help in its improvement.

4.3.2 Phase 2: Final Taxonomy

The data extraction process for the publications reviewed led to the identification of an initial list of twenty-nine social media features, with 70.1% of the studies (N=94) using more than one of these features. Based on the findings of the systematic review and the analysis of the Focus Group Study, the previously developed taxonomy from phase 1 was redesigned as shown in Figure 11. This is the first taxonomy for social media features intended for inclusion in behavioural interventions to be published. This taxonomy can be useful as a guide to intervention builders to select and include SMFs in their interventions. Researchers who wish to analyse the inclusion of SMFs in behaviour change interventions can also make use of it.

Michie et al., [118] presented a taxonomy for the reporting of Behaviour Change Interventions which focused on the different techniques used in such interventions. In line with this work, we are thereby proposing an extension of it to address social media features in Table 7.

High level categories from our proposed taxonomy	**Matching groups of techniques from Michie's taxonomy[118]**
1. Identity Representation	13. Identity
2. Communication	2.Feedback and Monitoring 3. Social Support
3. Peer Grouping	3. Social Support 6. Comparison of Behaviour
4. Data Sharing	1. Goals and Planning 2. Feedback and Monitoring 6. Comparison of Behaviour
5. Competitive	6. Comparison of Behaviour 10. Reward and Threat
6. Activity Data Viewing	1. Goals and Planning 2. Feedback and Monitoring 6. Comparison of Behaviour
7. Online Social Networks	1. Goals and Planning 2. Feedback and Monitoring 3. Social Support 6. Comparison of Behaviour 10. Reward and Threat 13. Identity

Table 7. Matching of Proposed Taxonomy With Michie's Taxonomy[118]

After the compilation of a descriptive list of social media features used in the interventions, an initial set of hierarchical categories was proposed. Out of the sixteen groups of techniques, in Michie's Taxoxomy, we have found that six of them are relevant to social media features used in behavioural interventions, namely: Goals and Planning, Feedback and Monitoring, Social

Support, Comparison of Behaviour, Reward and Threat and finally, Identity as shown in Table 7. However, due to that fact that some social media features tended to be in multiple groups of techniques, we have proposed our own hierarchical categorisation, better adapted for these features. This has been reviewed by two independent researchers to reach the final version presented in this thesis. It is important to note that this taxonomy does not include an exhaustive list of social media features but instead focusses on those that are included in the 134 studies in this review. The list of social media features has been adapted to match the proposed taxonomy which required in some cases the merging of two or more features (e.g. Blog and Testimonial & Experience Sharing) or the splitting of specific features into multiple ones (Social challenge / Contest /Competition).

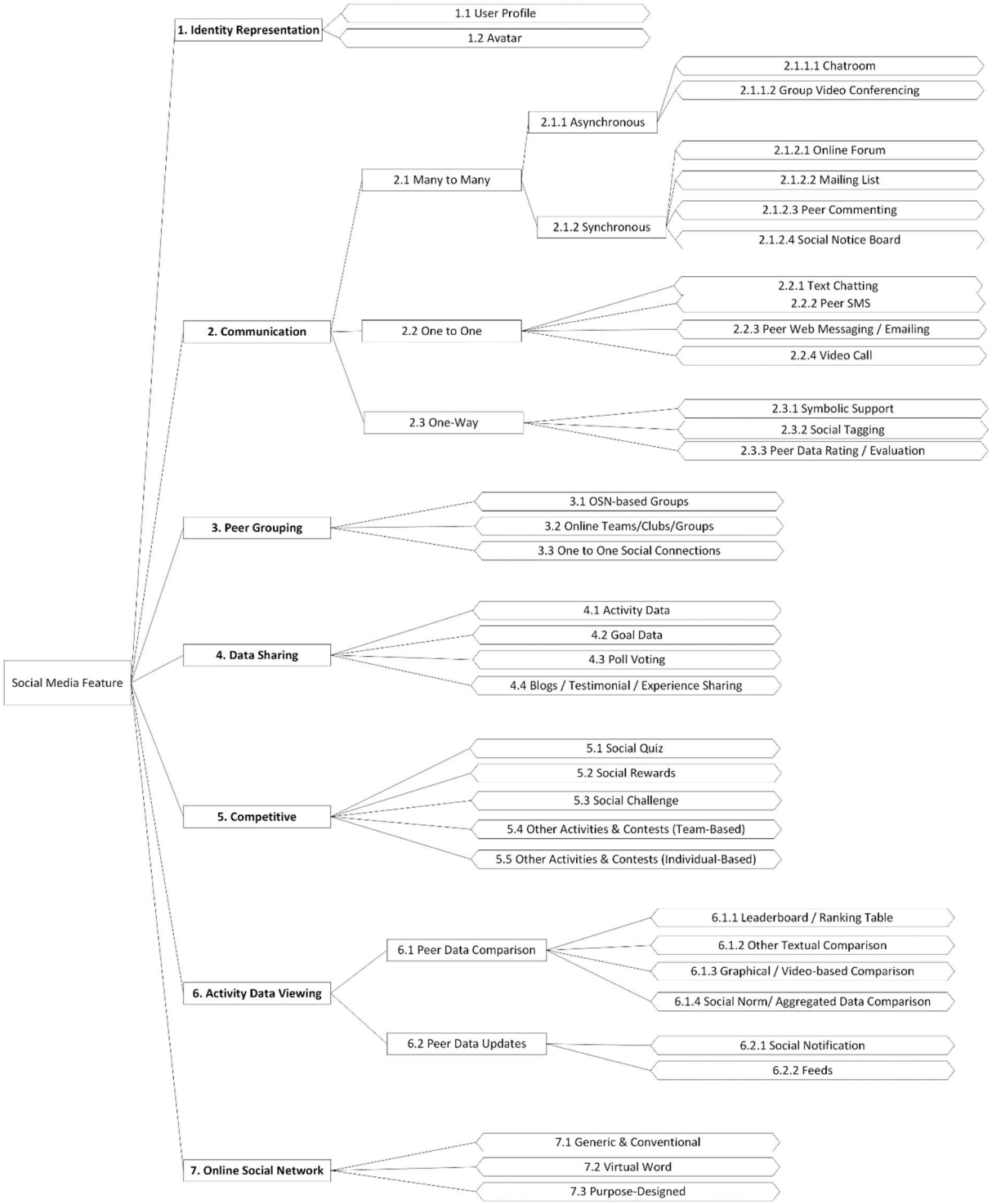


Figure 11. Taxonomy of Social Media Features

Following an iterative process during the systematic literature review (See Chapter 2.) that enabled the compilation of a list of SMFs, seven main categories of SMFs have been identified as described in Table 8. The provenance for the different categories is reported in Table 9.

1. Identity Representation	Used to provide information about an individual and his/her activities to peers and which are usually customisable by the participant. This is usually either in the form of user profiles or avatars.
2. Communication	Enable intervention participants to communicate with one another and which could be further categorised as many-to-many, (e.g chatrooms), one-to-one (e.g peer emailing) and one-way (e.g 'Thumbs up' or 'Likes').
3. Peer Grouping	Grouping of participants based on characteristics such as age, geographical locations or part of the same intervention arm while ensuring that they are aware about others in their group and with the possibility to have some form of direct or indirect communication. Groups can consist of a minimum of two participant or OSN based and non-OSN-based groups with more than two individuals.
4. Data Sharing	Enable participants of an intervention to share data about their activity, goals or experience to other participants and/or non-participants.
5. Competitive	Designed to introduce a competitive aspect in interventions through the use of features which enable participants to feel motivated while competing against one another (e.g social quiz).
6. Activity Data Viewing	Provide access to activity data of peers to participants through either regular updates (feeds and notifications) on a timely basis or enable them to compare their own data with that of their peers (e.g. Leaderboards).
7. Online Social Network	The use of an Internet-based platform for enabling social interaction among intervention participants. OSNs can be sub-categorised as either Generic & Conventional type (Facebook, mySpace, Twitter, etc), Virtual World (SecondLife), Purpose Designed (Yahoo Diet Diary, iWell, QuitNet, other intervention specific proprietary OSNs etc…). Online Social Network (OSN) although being considered as a social media feature usually act as a container for multiple other social media features.

Table 8. Social Media Features Categories

Categories	Reviewed Studies
1. Identity Representation	[4, 7, 14, 36, 45-48, 50, 53, 68, 70, 74, 76, 79, 91, 92, 94, 96, 98, 99, 103-105, 108, 110, 111, 116, 117, 119, 125]
2. Communication	[4, 6, 7, 14, 32, 36, 45, 46-55, 57- 65, 68-70, 72, 74-96,98-105, 107-112, 116, 117, 119, 122, 125]
3. Peer Grouping	[4, 7, 14, 36, 45- 50, 53, 65- 68, 70, 79, 87- 95, 98, 99, 103, 104-108, 110-117, 119, 125]
4. Data Sharing	[4, 36, 45- 49, 53, 57, 60, 67, 70, 75, 82, 88, 90, 92, 94-97, 103, 105, 107, 109, 111, 112, 116, 119]
5. Competitive	[4, 6, 7, 66, 68, 71, 76, 79, 82, 92-94, 98, 105-107, 111, 112, 119]
6. Activity Data Viewing	[4, 7, 14, 36, 45- 50, 53, 66, 68, 70, 71, 80, 87, 90-95, 97, 98, 103, 105, 106, 108-116, 119, 125]
7. Online Social Network	[4, 7, 14, 36, 45-48, 50, 53, 65, 70, 77, 79, 91, 94, 98, 99, 103-105, 107, 108, 111-117, 119, 125]

Table 9. The categories and their corresponding reviewed studies

A brief description of each social media feature is provided in Table 10:

Category/Sub-category	SOCIAL MEDIA FEATURE	DESCRIPTION
1. Identity Representation	1.1 User Profile	A digital representation of a participant with associated personal data which can be made viewable by other participants fully, partly or kept as private depending on interventions. Can include guest book for receiving comments, status, profile picture, avatar etc. Interventions using Online Social Networks, namely Facebook and QuitNet were assumed to have use profiles.
	1.2 Avatar	Avatars are graphical representation of participants and visible to one another.
2.1.1 Communication > Many to Many > Synchronous	2.1.1.1 Chatroom (Text-based)	Text-based synchronous group communication feature.
	2.1.1.2 Group Video Conferencing	Video-based synchronous group communication feature.
2.1.2 Communication > Many to Many > Asynchronous	2.1.2.1 Online forum	Web-based feature enabling participants to post and/or read one another's messages usually organised in the form of topics/threads.
	2.1.2.2 Mailing list	Electronic mail (email) used by intervention participants to send and receive messages to and from a group of participants in the mailing list.
	2.1.2.3 Peer commenting	Posting and reading of comments by intervention participants on posts, responses, blog entries, articles, etc. Includes Textual, Graphical, and Audio-based format. This excludes commenting on online forums. All studies using Facebook or QuitNet were assumed to have this feature.
	2.1.2.4 Social Notice Board (Group walls)	Area on an intervention's website or online group where participants can publish, read and comment on one another's posts.
2.2 Communication >One to One	2.2.1 Text chatting	Internet-based private messaging / chatting between two intervention participants in synchronous mode. All studies using Facebook were assumed to have this feature.
	2.2.2 Peer SMS	Phone-based text message/ Short Message Service (SMS) used by intervention participants to send messages to one another.
	2.2.3 Peer Web Messaging / Emailing	Electronic mail (email) or Internal messaging used by intervention participants to send messages to one another in Asynchronous mode. All studies using Facebook or QuitNet were assumed to have this feature.
	2.2.4 Video Call	Video-based synchronous communication feature for one-to-one video call among participants.
2.3 Communication > One-way	2.3.1 Symbolic Support	Support provided by participants to one another in the form of 'Thumb ups', 'Likes', 'Smile' and other related symbolic ways. All studies using Facebook or QuitNet were assumed to have this feature.
	2.3.2 Social Tagging	Participants viewing one another shared data can post tags (descriptive, categories, etc.).Tags posted or search terms used by participants can help generate tag clouds.
	2.3.3 Peer Data Rating / Evaluation	Participants providing ratings or evaluating one another's' shared data.
3. Peer Grouping	3.1 Online Teams/ clubs/ groups	Usually created by intervention builders to group participants into small teams/clubs to facilitate sharing and viewing of data among peers. Excludes all OSN-based groups.

	3.2 OSN-based groups	Groups created in online social networks usually by intervention builders and participants are either added by them or given the choice whether to join the groups. Participants in a group can share resources, photos, comments,etc.
	3.3 One-to-one social connections (friending/buddy nomination)	Functionalities enabling either participants to create virtual links between themselves and their peers or for researchers and therapists to create these links on the participants' behalf. All interventions making use of online social networks are assumed to include one-to-one social connections.
4. Data Sharing	4.1 Activity Data	Features enabling participants to either manually share their activity data or customising how their data is shared to others (what data, to whom, when, manual/automated, etc.).
	4.2 Goal Data	Sharing goal/planning data by a participant to peers. All studies using QuitNet were assumed to have this feature.
	4.3 Poll Voting	Voting in polls by participants and thereby sharing one's own opinions and choices to other participants.
	4.4 Blogs /Testimonial/ Experience Sharing	Testimonial-based posts shared in specific areas (for example blogs, forums, notice boards, specially designated locations) in textual, video or audio format and viewable by other participants who can then respond. All studies using QuitNet were assumed to have this feature.
5. Competitive	5.1 Social Quiz	Completing intervention related quizzes and comparing their results with other participants' aggregated results.
	5.2 Social Rewards	Virtual rewards (for example badges, trophies, points) received by a team or an individual participant for completing a challenge, winning a contest or as encouragement from friends and visible/announced to other participants.
	5.3 Social Challenge	Group-based challenges related to achieving behaviours targeted by interventions created by intervention experts or the participants themselves.
	5.4 Activities & Contests (Team-based)	Competitive activities or contests undertaken by a participant as part of a group/team against other group(s)/team(s).
	5.5 Activities & Contests (Individual-based)	Competitive activities or contests undertaken by a participant as an individual with the possibility to compare their performance with other participants.
6.1 Activity Data Viewing > Peer Data Comparison	6.1.1 Leaderboard / Ranking Table	A scoreboard or ranking table showing participants and their current scores usually sorted by highest achievers.
	6.1.2 Other Textual Comparison	Other form of data viewing in the form of text (for example, comments by participants describing their achievements) which enables a participant to compare other participants' activities / achievements with their own.
	6.1.3 Graphical/Video-based Comparison	Enabling the graphical/video based comparison of peers' data (for example, an image of a race track with icons/avatars representing peers) which enables a participant to compare other participants' activities /achievements with their own.

	6.1.4 Social Norm / Aggregated Data Comparison	Feature to enable a participant to compare his/her own performance/data with an average of all the participants in his/her group.
6.2 Activity Data Viewing > Peer Data Updates	6.2.1 Social Notification	Notification in the form of graphical icons or text-based description sent to intervention participants to inform them about activities, changes in status, etc. of other participants.
	6.2.2 Feeds	Frequently updated data for the different activities related to targeted behaviours undertaken by other participants formatted in such a way that a particular participant can follow them. All studies using Facebook or QuitNet were assumed to have this feature.
7. Online Social Network	7.1 Generic & Conventional	An Internet-based platform for enabling social interact among its members. Generic & Conventional OSNs are usually accessible to the general public and by design are not intended for use within interventions although they provide some functionality such as privacy settings to restrict resources. Examples include Facebook, Twitter, MySpace
	7.2 Virtual World	Three-dimensional version of online social networks such as SecondLife.
	7.3 Purpose-Designed	Online social networks designed for interventions addressing specific behaviours. Some of these OSNs are available as off-the-shelf applications while others are designed for specific interventions and are proprietary.

Table 10. Social Media Features Description

4.4 Chapter Conclusion

We have presented a taxonomy for SMFs for behavioural interventions intended to standardise and guide the inclusion of these features by intervention builders. We have also demonstrated how this taxonomy could extend an existing taxonomy for behavioural interventions which will make cross-study comparisons easier and more accurate in the future. The analysis of the systematic review (See Chapter 2.) has also been used in the development of this taxonomy while the taxonomy itself has also been used to help in the classification of the different SMFs identified during the review process.

The taxonomy of SMFs reported in this chapter will facilitate the task of researchers and intervention builders in selecting the most appropriate SMFs and incorporate these into their interventions in a more standardised way. This addresses the research question "How *can SMFs be organised so as to standardise, facilitate and guide their inclusion in behavioural interventions?"*. Extending the taxonomy to complement an existing related one has also been explored. The final taxonomy has been published as part of the same journal paper for the SLR from Chapter 2. as it complements the latter [132].

Chapter 5. Pilot Experiment of Social Media Feature

This chapter describes the design and implementation of an experimental SMF prototype which will be referred to as the 'Popular Tools Feature'. The evaluation of the prototyped SMF was performed from a digital intervention experts' perspective through expert review, and also from end-users' perspective using a small scale feasibility study.

5.1 Overview

The lack of a generic framework to create DBCIs which could incorporate SMFs was discussed in both Chapter 1. and Chapter 2. The findings of the focus group study (See Chapter 3.) helped in determining that polls as an SMF was one among the most sought after features by intervention builders. Chapter 5. reports on a pilot experiment aimed at determining the feasibility of using a generic framework for creating DBCIs which incorporate SMFs. In this instance, a poll-voting mechanism has been implemented to enable participants to implicitly vote for their favourite components by clicking on them.

5.2 Motivation

Based on the focus group analysis reported in the previous chapter, it was found that digital intervention builders were convinced about the positive impact of SMFs when integrated within interventions. However, there was a unanimous agreement among them that the suitability of specific SMFs would vary based on the contexts. Similarly, their requirements in terms of privacy protection, user-control, etc., may also differ accordingly. In order to determine this appropriateness factor of SMFs, they would need to be trialled out on experimental basis and the data gathered could then be analysed. At the time of writing of this thesis, no generic SMF feature was available for easy integration into DBCIs while providing intervention builders with customisation flexibility.

Through the analysis of the focus group discussions, it was determined that polls were one of the SMFs that the intervention builders were the most enthusiastic about for future integration in their interventions. They also discussed different strategies for aggregating intervention end-users' usage data for producing poll results without them having to explicitly cast votes.

Taking into consideration the factors summarised above, it was decided to design and implement a first experimental SMF prototype, the evaluation of which would help towards refining the methods to be adopted for the creation of other SMFs and ultimately help answer the research questions:

> *'How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?'*

&

'Do end-users perceive SMFs as useful and user-friendly components within interventions?'

The Popular Tools Feature enables intervention end-users to view lists of tools which are ranked according to their popularity based on either the user's own data or the aggregated data of all the intervention end-users. The feature can be accessed through a button which provides the user with the options to either view the popular tools list based on their own data, or that of all end-users. Once the viewing option is selected, the list of tools is displayed and the user can click on a 'Launch' button located next to each item in the list to open that particular tool.
For the purpose of this experiment, an existing digital intervention, created using a generic framework known as "LifeGuide ToolBox", has been modified.

5.3 The HealthyMind Application

An existing native Android-based application used for a behavioural intervention study known as HealthyMind was developed at the University of Southampton. HealthyMind (see Figure 12) offers nine scientifically proven tools that are designed to help end-users deal with stress and enhance wellbeing [127]

Figure 12. HealthyMind Tools Screen

The HealthyMind App collects end-users' data and transfers it over to the server for the intervention builders and scientists to analyse. However, the end-users do not have access to this data. The LifeGuide Toolbox is a generic framework under development at the University of Southampton for assisting intervention builders in creating DBCIs in the form of smartphone applications without any computer programming by using a graphical authoring tool. Our

prototype extends the LifeGuide Toolbox App and Server to allow the aggregating of end-users' data about tools' usage (which tools they use, the usage frequency and ratings that they attribute to each tool) into anonymised statistical data which can be sent back to the application from the server. The statistical data can then be used in a new SMF, that we have named 'Popular Tools', to show to users a list of tools sorted by usage and rating popularity.

5.4 SMF Prototype Design

The prototype extends the LifeGuide Toolbox client and server, along with additional information in the intervention configuration file. The design has been structured as follows: Firstly, an overall architectural diagram for the prototype is described, secondly, the main additional components that were implemented are described in more details and finally, the screen layout designs are presented.

5.4.1 System Architecture

The high-level system architecture shows the interactions between the main components of the existing framework (see Figure 13). The parts and components that have been added to the existing architecture to extend it for the purpose of our work is shown in

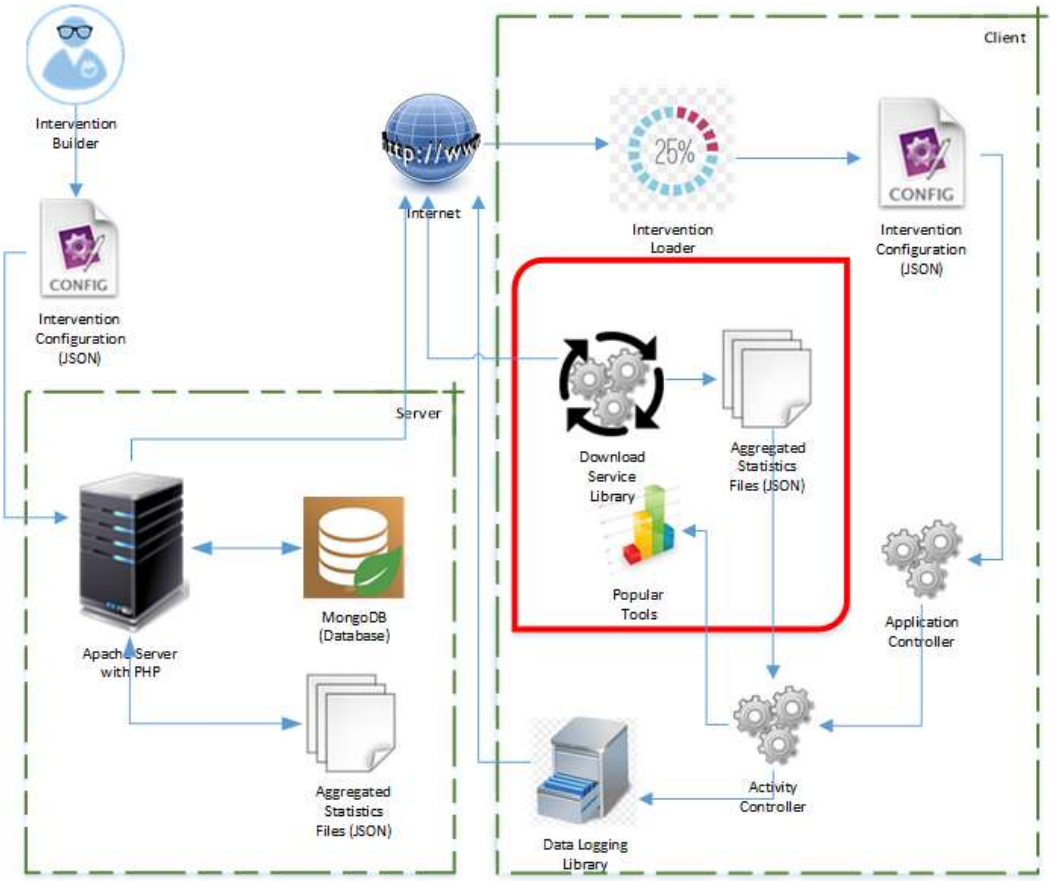


Figure *14*.

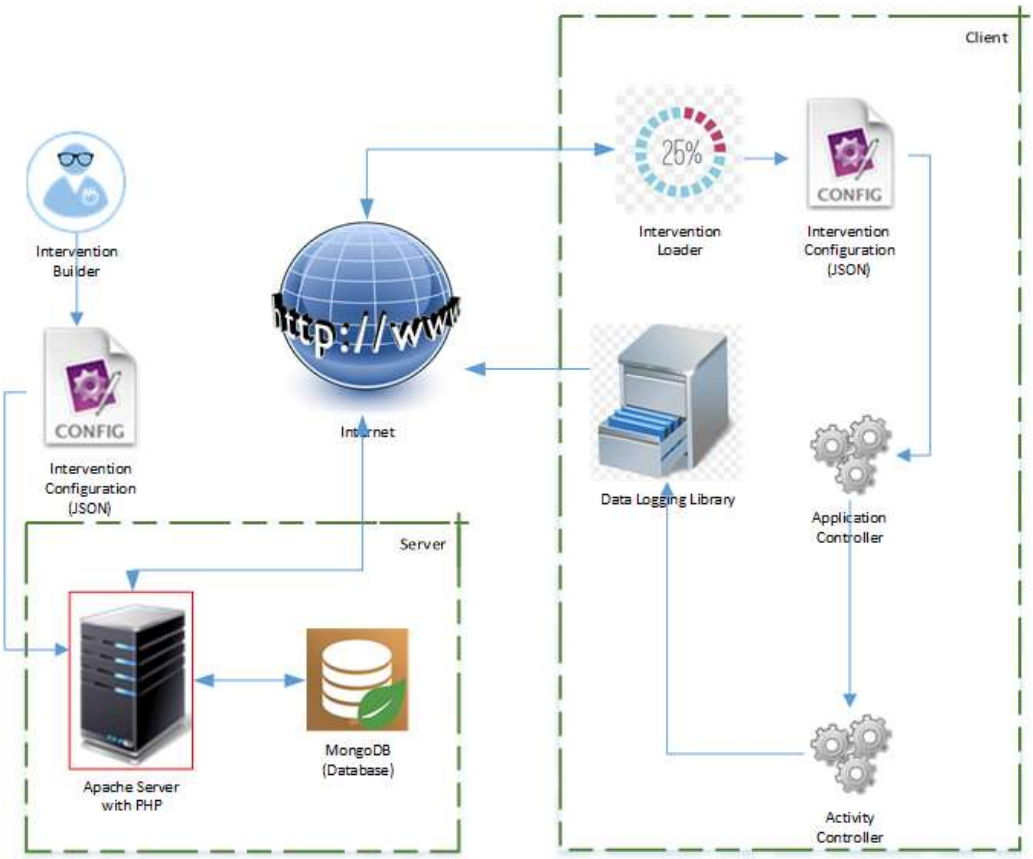


Figure 13. Lifeguide ToolBox Framework Architectural Diagram

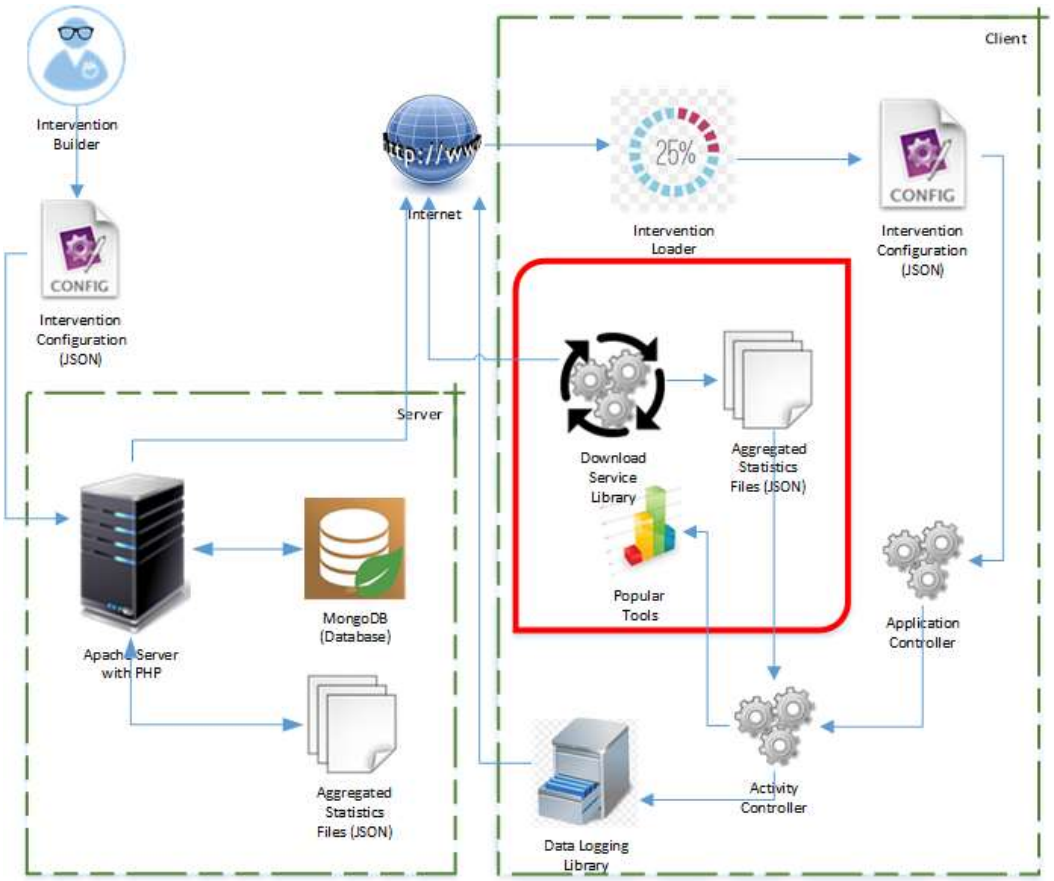


Figure 14. Extended LifeGuide ToolBox Framework Architectural Diagram with SMF Prototype Integrated

- Intervention builders create an intervention configuration file using a text editor. The file is uploaded manually to the server through a web-based interface.
- The server stores file into the database along with other intervention-related and participants' data.
- The database is queried by the server either upon request from clients or periodically. However, each client can only receive data about the intervention tools or its own usage.
- The client requests for a specific intervention's configuration from the server through the Internet. The server responds to requests such as available interventions and intervention configurations from Clients through the Internet.
- The intervention's configuration is saved locally as a JSON file (in the phone's internal memory).
- The Application Controller uses the intervention configurations to call other appropriate Activity Controllers. The Activity Controller loads the appropriate activity onto the phone's screen.
- Data collected in different activities is passed to the Data Logging Library responsible for forwarding the data to the server for storage. In case no Internet connection is available the logged data is temporarily stored on the phone pending availability of a connection.

For the purpose of the pilot experiment, the existing components required some modifications to accommodate new ones. The new components, name, the Download Service Library, Aggregated Statistics Files and the Popular Tools, can be identified in , with a red border. The main differences of the extended framework compared to the existing one are described below: In the extended framework, the server also responds to the client with aggregated data of other users in the form of Aggregated Statistics Files.

- For each intervention, and each intervention user, the server generates aggregated statistics files about tools usage and ratings periodically (e.g once daily) as a CRON job.
- The existing intervention configurations have been extended to include information about periodical downloading tasks for statistics files; these tasks configurations are passed to the Download Service Library. In turn, it attempts to download data from the server at a scheduled time or whenever an agreeable connection to the Internet is available. The data received is then stored locally as JSON files (in the phone's internal memory).

- When an Activity Controller for the Popular Tools feature is active, it loads the data stored from the Aggregated Statistics Files from internal memory.

5.4.2 Main Components

The main components of the prototype including both the server-side and client-side are described in the next sections.

5.4.2.1 Intervention Configuration file

The Intervention Configuration file (See Appendix I for a sample configuration file) contains all the necessary configurations and settings in JSON format. A web-based authoring tool developed to create intervention automatically generates the corresponding intervention configuration as a JSON file. This has been extended as described in Chapter 6. (Section 6.4) to incorporate SMFs. The configuration file can also be edited using a text-editor. This file is used by the mobile application for the customisation of the intervention. The main information that it usually contains are the Intervention's ID, the groups that end-users can be assigned to, and the content for the intervention.

The following additional two sections are required in the configuration. Firstly, settings for configuring the **Download Service Library** and secondly, the **Popular Tools feature settings and information**.

Settings for the Download Service Library includes the following:

(i) The interval / time period between updates;

(ii) Whether to use only WiFi or all connection types;

(iii) A list of all download tasks with their respective IDs and output file names.

The **Popular Tools feature settings and information** is part of a sequence of a Survey Activity (described in subsection 5.3.2.3) followed by a Poll Result Activity. The Poll Result Activity is a new component added to the framework to display aggregated data of all the intervention participants to users. The questionnaire is used to provide end-users with information about the feature and present them with two choices; Own Data and All Participants (shown in Figure 19). Based on the answer to the questionnaire, the Poll Activity is customised by using the appropriate statistics file.

5.4.2.2 Server Side

Two PHP scripts, newly-created in the extended framework, are used for querying the MongoDB database to retrieve a list of all interventions and the tools that they contain. Script 1 is used to generate tools usage and ratings statistics with all end-users' data aggregated while script 2 will generate the statistics for each individual end-user separately. The algorithms for Script 1 and 2 are shown in Figure 15 & Figure 16 respectively.

```
Query database for a list of intervention
For each intervention
    Query database for list of tools
    For each tool
        Query database for ratings and usage data
        Update tool with ratings and usage information
    End For each
    Write to JSON file (intervention_id, last_updated, tools_statistics)
End For each
```

Figure 15. Algorithm for Script 1; Used to Generate Tools Usage and Ratings Statistics as Aggregated Data

```
Query database for a list of intervention
For each intervention
    Query database for a list of participants
    Query database for list of tools
    For each participant
        For each tool
            Query database for ratings and usage data
            Update tool with ratings and usage information
        End For each
        Write to JSON file (intervention_id, last_updated, tools_statistics)
    End For each
End For each
```

Figure 16. Algorithm for Script 2; Used to Generate Tools Usage and Ratings Statistics for Each Individual User Separately

These two scripts are executed as CRON jobs once daily by the server to generate aggregated statistics files which are stored on the server. Whenever mobile clients request for these files, their requests have to include the task ID and intervention ID along with their user-tokens. The server then checks whether the task ID corresponds to all end-users or a single user and send the appropriate statistics file in JSON format.

5.4.2.3 Mobile Application (Client)

The Mobile Application makes use of the existing framework which already provides a set of core functionalities for DBCIs. The four existing activity types are: Survey, Diary, Information, Planner and Settings as shown in Figure 17. For the purpose of this prototype the Survey Activity has been used along with a new activity type created for Polls, henceforth referred to as the MultiPoll (short for Multiple Polls) Activity.

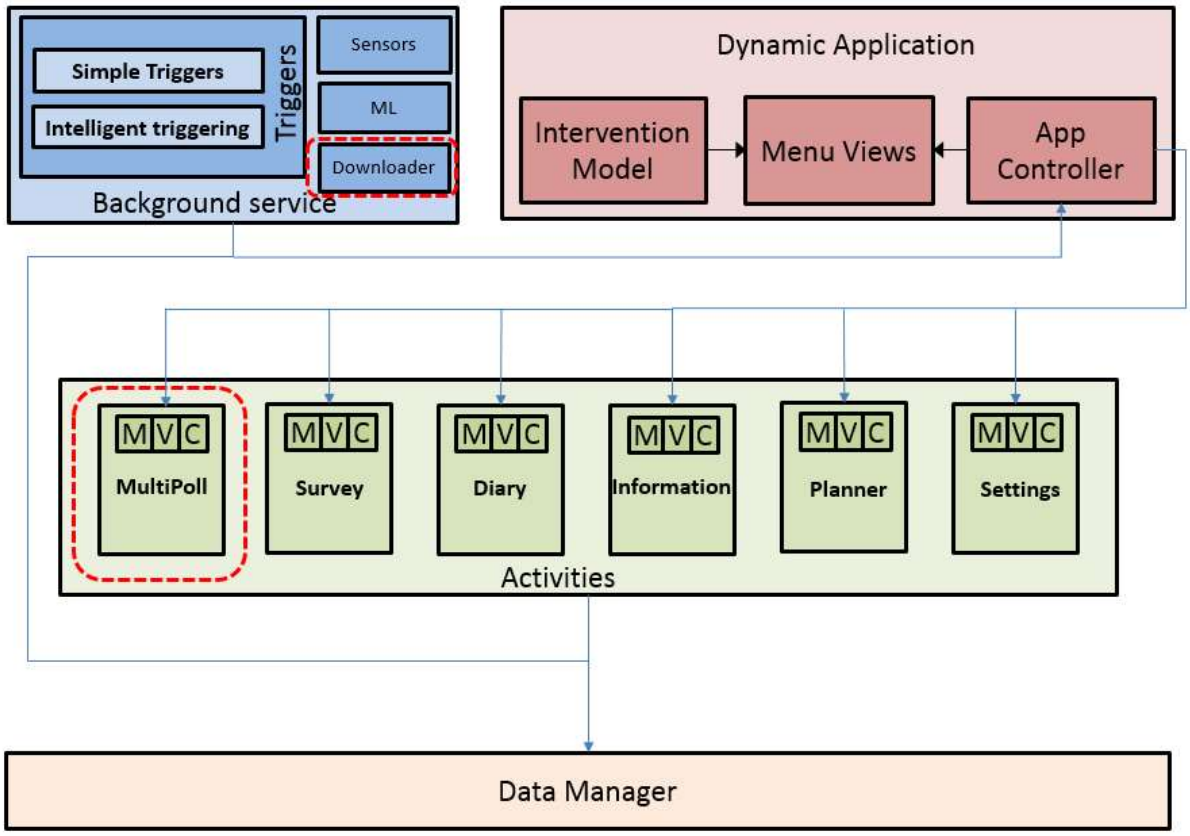


Figure 17. Mobile Application Framework Architecture showing new activity controller and background service.

The major parts of the MultiPoll activity are described below:

The Activity Controller is responsible for loading the current portion of settings and information from the intervention configuration file and creating a new Intent, which is an abstract description of an operation that needs to be carried out, to be passed to the appropriate MultiPoll Activity class.

The Activity class retrieves all necessary data from the Intent, and creates tabs which are then populated with a sorted list of tools. Unsorted list of tools along with statistical data are stored in the phone's internal memory after getting downloaded from the server by the Download Service Library (discussed in the next section).

5.4.2.4 Download Service Library (DSL)

The extended framework downloads the initial list of interventions and the selected intervention configuration file from the server when the application is launched and before being ready to use. Since these are currently hardcoded, we are adopting a more generic way for performing downloads from the server while the intervention application is running. This allows intervention authors to specify which data updates they would like to download from the server and at which time interval. For the purpose of the current SMF prototype, the

Download Service Library (DSL) is used to download statistical data about tools in terms of usage and ratings from the server once daily.

In order to set up the DSL, an alarm has to be scheduled in the Android system and the different downloads/updates are added as objects. When the alarm is triggered, the DSL checks for Internet connectivity and, if a suitable connection mode is available (can be configured to Wi-Fi only or all modes), the downloads are undertaken. Otherwise, the DSL starts a background service to listen for Internet connectivity changes and perform the downloads when a suitable connection becomes available.

5.4.3 Screen Layout

The graphical user interface for the prototype uses four screens as illustrated in Figure 18. - Figure 21.

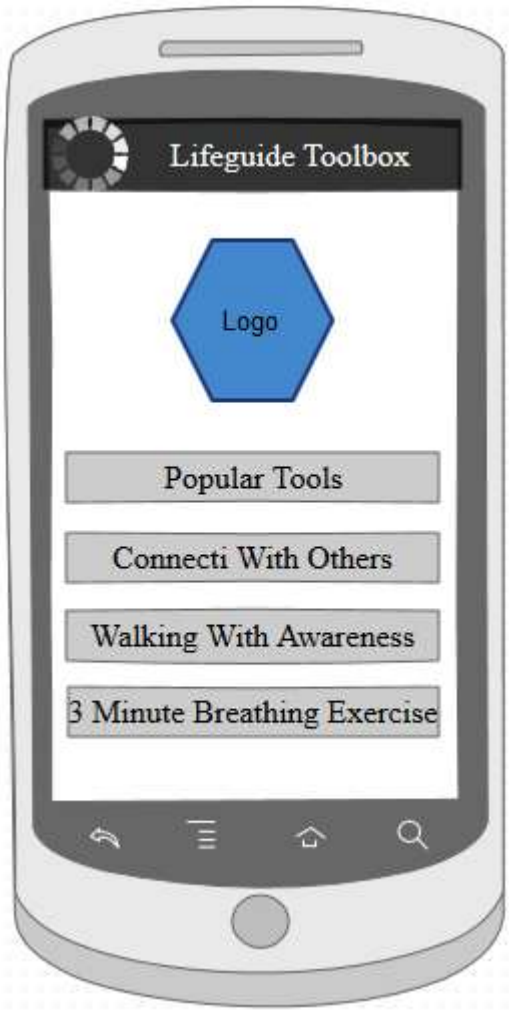


Figure 18. Button to Access Popular Tools Feature

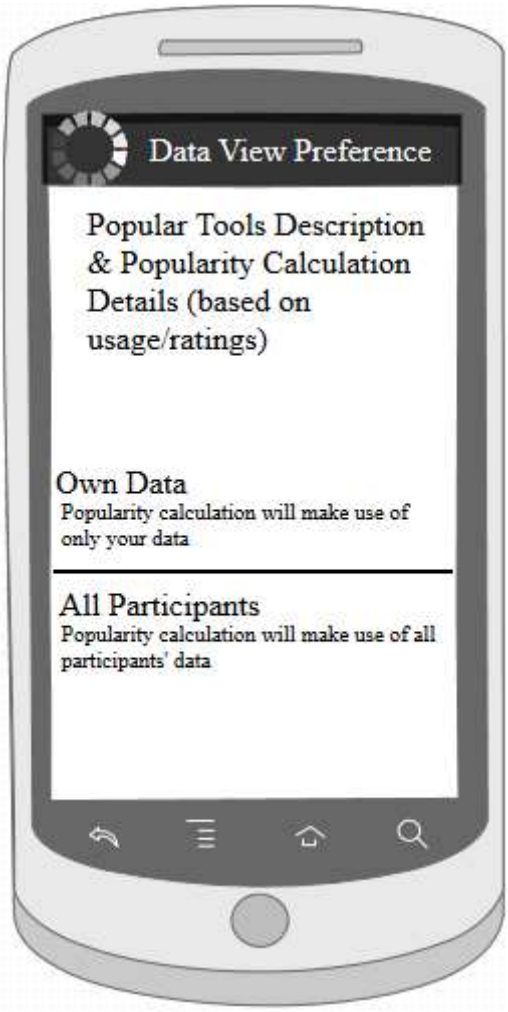


Figure 19. Data Viewing Preference Screen

In order to access the popular tools feature, end-users click on the button with the label 'Popular Tools'. While in Figure 18. the button is located in the tools menu as the top-most item, this can be repositioned anywhere by intervention authors within the application's menus. Similarly, authors have the flexibility to change the button's label to better match their interventions' context.

After clicking on the button shown in Figure 18. to launch the Popular Tools feature, the screen loads an activity of type survey (see Figure 19). Again, the labels and text descriptions are fully editable through the intervention configuration file. The survey consists of a question with two choices which can be selected one at a time. The first answer uses statistical data of the current application user while the second option loads the aggregated data of all the

intervention participants. As soon as the user clicks on either option, the next screen is loaded (Figure 20.).

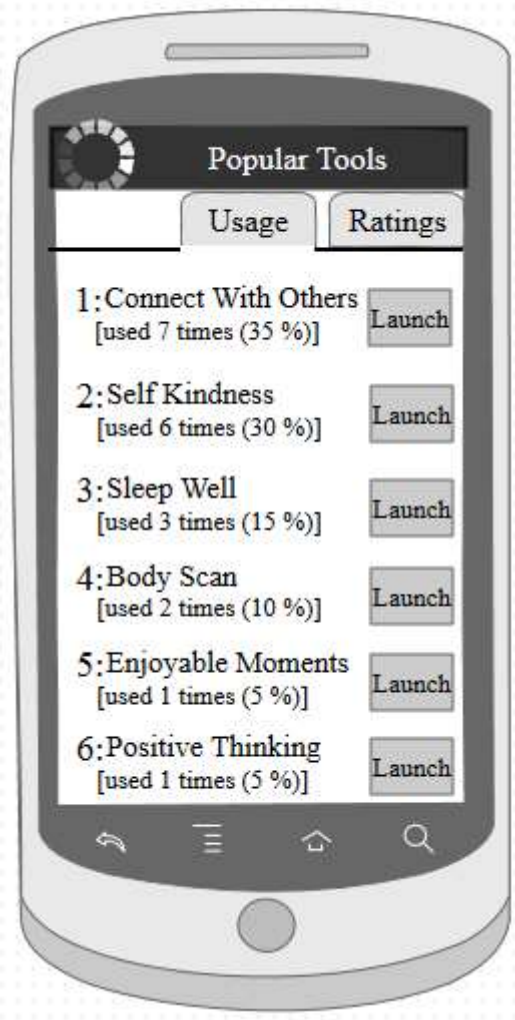


Figure 20. Tools Listing Ranked by Usage

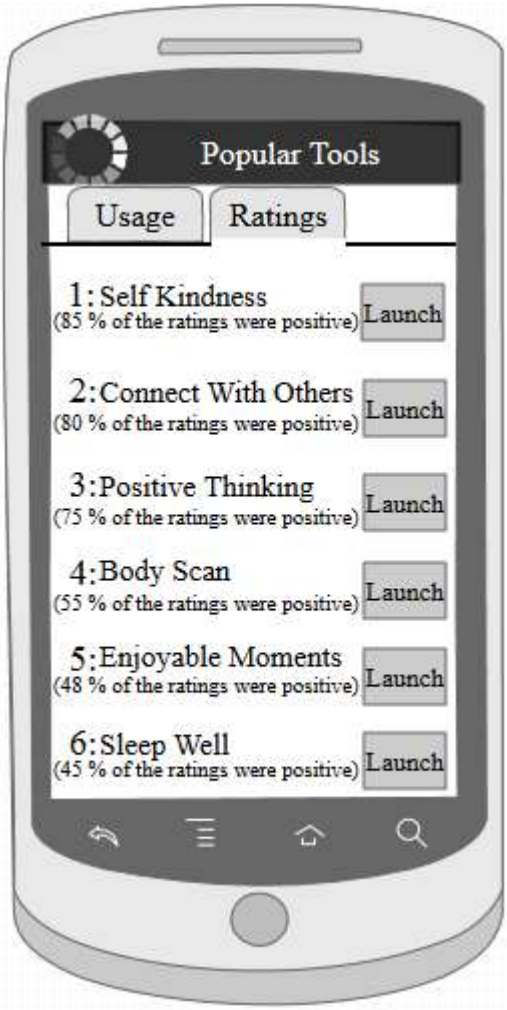


Figure 21.Tools Listing Ranked by Ratings

Figure 20. shows the ranked list of tools sorted by usage. It uses either the current user's data only or that of all participants depending on the choice made on the previous screen (Figure 19.). The list of tools is scrollable in case there are more tools than can be fitted on screen at one go. The 'Launch' button next to each tool should be used to open up the corresponding tool. In case the user would like to view the tools ranked by ratings, he/she can either click on the 'Ratings' tab at the top or swipe horizontally across the screen.

The screen in Figure 20. is displayed when a user clicks on the 'Ratings' tab or swipes horizontally across the screen. It has the same functionality as described for the previous figure in terms of launching any tool in the list.

5.5 Implementation Approach

A bottom-up approach was adopted for the implementation of the different components of the Popular Tools feature. This was motivated mainly by the fact that the UBhave framework

already provided us with a robust and tested code base which could be used for integrating the different parts of the components as they were being implemented. As a result, early testing could begin as soon as the first parts were integrated into the framework while the unimplemented parts were replaced with stubs.

5.5.1 Technologies Used

Since the prototype was meant to be integrated into the LifeGuide ToolBox framework, it was only reasonable to adopt the programming languages and platforms already being used and which had proven to be both efficient and reliable. The server side runs on the Apache HTTP Server (V.2.4) and the scripting was done using PHP and the Slim Framework. On the mobile client side, the application was coded in Java for the Android platform (tested in Android 5.1). The intervention configuration file and statistical files used JavaScript Object Notation (JSON) as a data-interchange format.

5.6 Evaluating the feasibility for creating generic SMFs and their usability

The SMF feature, 'Popular tools' developed as described in the previous sections of this chapter was evaluated using a two-phased approach as described below.

5.6.1 Methods

This section describes the research methodology adopted for the purpose of evaluating the SMF prototype. This includes details about participants, data collection strategies and procedures.

5.6.1.1 Participants

Two categories of participants have been recruited for the evaluation; firstly, digital intervention experts who participated in focus groups organised in relation to this project have been re-invited to participate in this study and secondly, a number of undergraduate and postgraduate students (both taught and research-based) have been approached.

5.6.1.2 Data Collection and Analysis

Ethical Approval was sought and obtained from the ECS Ethics Committee - University of Southampton prior to organising the focus groups (Reference Number: ERGO/FPSE/14262). Both verbal and written informed consent was sought and obtained from all participants. They were provided information about how their data would be used, stored and destroyed while ensuring confidentiality.

The Concurrent Think Aloud (CTA) technique was used whereby participants were provided with a list of tasks (see Appendix C) to accomplish by using the SMF while being encouraged to think aloud. The investigator then took hand-written notes of his observations and the comments he heard while the participants were undertaking the different tasks. In addition, the comments were audio-recorded through a university-owned smartphone.

After completing the tasks, participants were handed a questionnaire which they were instructed to fill (see Appendix D). The questionnaire is an adapted version of the widely used System Usability Scale (SUS) questionnaire originally proposed by John Brooke [128]. SUS was chosen due to its high reliability (alpha=0.91) as reported by Bangor et al., [129] who also found that it could be used for evaluating a wide range of interfaces while using relatively small sample size. The questionnaire was modified to replace the word 'system' with 'feature' as the evaluation targeted only a feature within an application and the word 'awkward' was inserted in between brackets just after the word 'cumbersome' as suggested in the work of Bangor et al., and Finstad et al., [129, 130], as some of the participants were non-native English speakers. In case the participant was a researcher, additional questions were asked by the investigator verbally using the list provided in Appendix E).

5.6.1.3 Procedure

For the purpose of this evaluation, an existing digital intervention known as HealthyMind, created using the UBhave framework has been used. It consists of tools with labels such as "Connect With Others", "Walking with Awareness", "3 minute Breathing Space", etc. A few of these tools are immediately available for use while the others are locked initially. Users can use each available tool and after each usage, indicate whether it has been useful or not. Subsequently, more tools are unlocked. Due to the nature of this SMF prototype which requires all participants to be able to use any tool as from the beginning, HealthyMind has been modified and all the tools have been initialised as being unlocked.

- Dummy data had been used for enabling the server to produce tools' usage and ratings statistics files for the tools.
- The procedures for Social Science researchers differed slightly from that of undergraduate/postgraduate Students. For both type of participants, the evaluation was carried out on a one-to-one basis in order to enable the investigator to observe and take notes for each individual participant.
- Participants were informed that hand-written notes would be taken along with audio-recording during the evaluation study and that any participant wishing to withdraw from the study, could do so freely at any point. This information was communicated to participants in the information sheet and they were also verbally reminded at the beginning of the session. Participants were requested to sign a consent form before the session started. Printed consent forms were made available in the room for participants to sign.

- The participants were provided with a smartphone having a profile containing a version of the digital intervention application without the Social Networking Feature (SMF).
- The participants were then verbally given a guided walk-through of the application lasting approximately five minutes for them to get a proper understanding of how it works.
- Participants were then asked whether they have any questions.
- The same smartphone was taken back from them and the currently loaded profile was switched to a second one which contained a version of the digital intervention along with the SMF and handed back to the participants.
- Participants were then given a sheet containing a list of tasks (See Appendix C) that they had to undertake while using the mobile application. They were briefed about the list of tasks and encouraged to think aloud while doing the work.
- The investigator took hand-written notes while the participants undertook the tasks. Similarly, comments were audio-recorded with the help of a university-owned smartphone.
- After completing the tasks, the participants were given a questionnaire to fill in. (see Appendix D).
- In case the participant was a researcher, he/she would be requested to provide expert reviews from their own perspective while undertaking the task in the list provided.
- Researchers were requested to fill only the SUS questionnaire and they were verbally asked a few additional questions. (see Appendix E).
- At the end of the session, the investigator verbally debriefed the participants and handed out a debriefing sheet. The investigator then thanked the participants and escorted them to the exit.
- The analysis of the evaluation was performed using the data gathered through notes-taking, audio-recording and questionnaire.
- A quantitative analysis approach was used for the SUS questionnaire while a qualitative approach was taken for the researchers' interviews.

5.6.2 Results and Discussions

A total of twenty-one participants took part in this evaluation study. Among the participants, six were researchers, six were undergraduates and nine were postgraduate students.

All the evaluation participants were able to launch the application and identified the location of the Popular Tools feature button successfully. However, two among them expressed doubts

about its location and mentioned that they were guessing that it would be in the 'Tools' Section (which was correct).

While most of the evaluation participants understood the concept of 'Own Data' and 'All Participants', one of them remarked that since she had not used the application before, it would not be her own data:

"Ok, i think i dont have my own data but someone else has obviously used" (P9)

Approximately 60 percent of the evaluation participants failed to notice in the 'Popular Tools' feature the presence of the 'Ratings' tab which could be accessed by clicking on it or swiping horizontally across the screen. As a result, they only used the default ranking which was based on tools' usage.

All the evaluation participants were able to figure out that the first tool in the list was the most popular one and they all scrolled vertically to locate the least popular tool.

SUS scores are usually compared with existing average scores for interpretation. The mean SUS score using data from 2,324 surveys in 206 studies was 69.69 [129]. A system obtaining a SUS score equal or more than this mean figure can be interpreted as having good usability properties. However, as discussed by the same authors, the score tends to vary significantly based on the type of interface being used in the evaluation. To the best of our knowledge there was no study that had published aggregated SUS scores for mobile-applications. Since smartphones' interfaces were more closely related to Graphical User Interfaces (GUIs) of computers than old models of cell-phones, it was determined that the closest equivalent to be chosen for comparison purposes in this current evaluation would be GUI for OS-based Computer interfaces. GUI was reported to have a mean SUS score of 75.24 according to Bangor et al., [129]. Although it was technically possible to use SUS using a sample size of two participants, according to Tullis and Stetson [131], reliable results could be obtained with a sample of at least eight participants. However, due to a mixed set of evaluation participants involved in the study, it was deemed appropriate to discuss the results in light of their respective sub-categories despite the smaller than recommended sample sizes for these sub-categories. Eventually, the results of the two categories are discussed; one combining all the evaluation participants except for intervention builders while the second, which included intervention builders as shown in Table 11.

Participant Category	Sample Size	Mean	Standard Deviation
Undergraduates	6	81.67	16.48
Postgraduates (Taught)	5	67	10.37
Postgraduates (Research)	4	85.62	18.3
Intervention Builders	6	91.25	6.85
Combined Categories Excluding Intervention Builders	15	77.83	16.28
Combined Categories Including Intervention Builders	21	81.67	15.36

Table 11. SUS questionnaire results calculated from the gathered data

With an overall mean of 81.67, which when compared to the reported 75.24 mean value for GUIs by Bangor et al., [129], the SMF could be considered as being well above the average SUS score for usability. However, it should be noted that this combined mean included intervention builders who would have extensive past experiences in DBCIs. When this category was excluded, the mean score dropped to 77.83 which was still slightly above average and the standard deviation had a quite small change of +0.92. The score would have been better had the mean from the category 'Postgraduates (Taught)' been higher. Evaluation participants from that specific category were all international students for whom English was not their primary spoken language and many among them struggled in understanding the SUS questionnaire. As a result, this could have impacted on their answers.

In order to understand the variability of the mean score and confirm that the sample size used for the evaluation was sufficient, the mean SUS score of different number of evaluation participants were computed as shown in Figure 22. As was expected, the order in which the first eight participants were added to the list impacted on the mean SUS score considerably even if each participant was randomly picked and added to the set. However, the variation range tended to decrease and eventually a stable SUS Score was achieved.

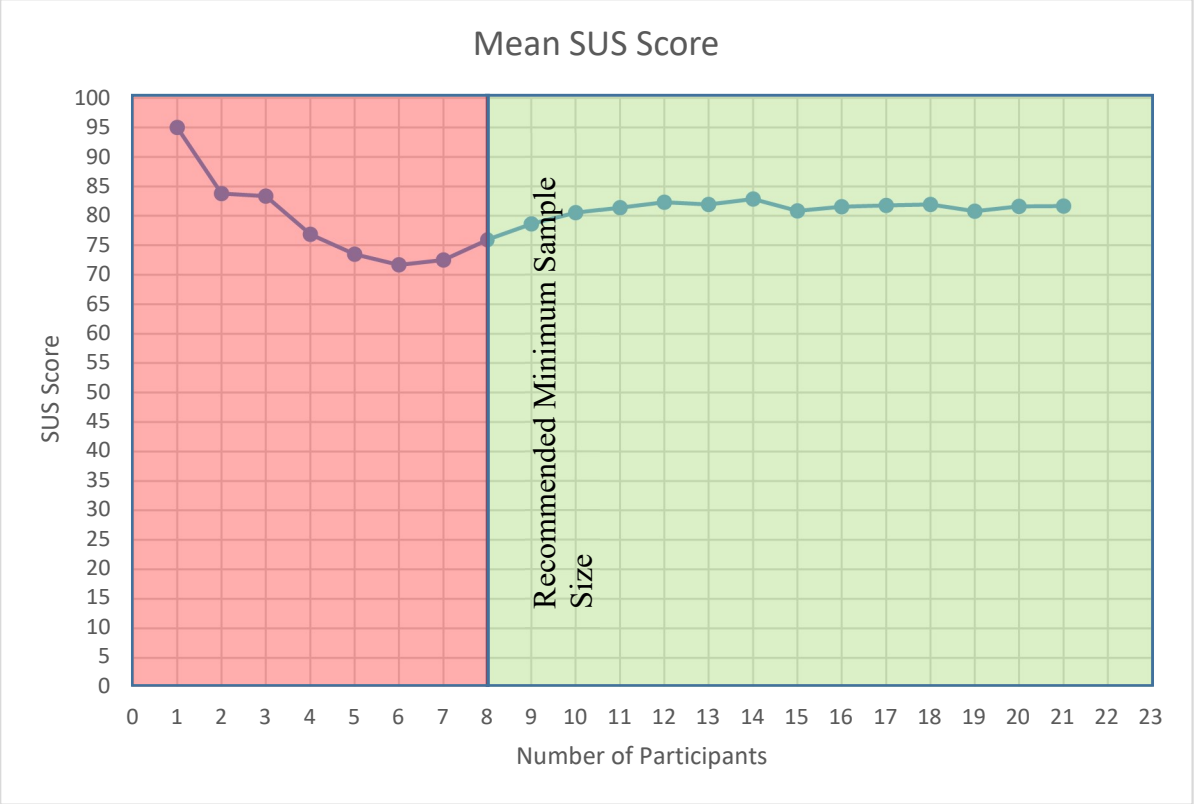


Figure 22. Mean SUS Score with varying number of participants

As can be seen, a stable SUS score was reached from ten evaluation participants onwards. Therefore, it could be interpreted that an adequate sample size had been used for the usability evaluation using the SUS questionnaire irrespective of the order in which evaluation participants were selected provided a minimum sample size of ten was used.

Section B consisted of a set of eight questions which included a combination of 'yes/no' styled questions and open-ended questions (see Appendix D). This section was used only for end-users (n=15). It should be noted that one of the end-users answered only the 'yes/no' styled questions. The results are presented and discussed in the next paragraphs.

Question 2.: ***"****Briefly describe the main functionalities of the 'Popular Tools' feature."*

From an evaluation perspective, it also sought to confirm whether the end-users had managed to understand the SMF. Most of them (10 out of 15) provided relevant and expected descriptions of the functionalities. An example of a description given by an end-user was:

> *"Option to use your own data or data from everyone using the app. Ranks tools based on usage stats, or how highly each tool is rated." (P1)*

However, three end-users tried to describe the mobile application as a whole rather than only the SMF; One of these responses is quoted as follows:

"Mainly to improve our daily lives,give you some suggestions on how to do it (example: how to sleep well, positive thinking, etc)" (P5)

Quickly developing an understanding of the main functionalities of an SMF would normally be crucial for the success of future SMFs deployed within DBCIs due to the fact that no training is usually provided to intervention participants. Since most of the end-users demonstrated that they understood the feature, it could be interpreted that its simplistic design had an important role. As far as the responses describing the overall application are concerned, it would be premature to conclude that the end-users did not understand the SMF itself as it could be that they had wrongly interpreted the question instead.

Question 3: "*When using the feature, did the positioning of the button to access the 'Popular Tools' section matter and why?"*

All the end-users unanimously agreed that it was in an appropriate location within the application and being at the top of the list made it easy for them to locate as described in the two quoted reasons by end-users:

"Easy access to popular tools from top of the tools list." (P1)

"It is intuitive for users." (P19)

The fact that the 'Popular Tools' button was located within the 'Tools List Menu' accessed through the 'Tools' button might have provided some guidance to end-users as a few (4 out of 15) were overheard voicing out the word 'tools' when deciding upon which button to click from the main menu. Placing the button at the top of the list of tools was also a good approach adopted in the layout design which ensured that end-users could see it without the need to scroll-downward.

Question 4: "*Was it beneficial to get data aggregated from: (i) all the intervention participants? (ii) only your own interaction with the application?"*

For the first part, almost all the end-users, except for one, were positive about it. However, fewer among them believed that it would be beneficial to them to receive their own data (11 out of 15). This shows that more end-users were interested in having access to others' data than to their own which highlights the importance and relevance in providing this type of access. However, a comfortable majority among the end-users also expressed their willingness to have access to their own data.

Question 5: "*If you were given the choice of whether to share your anonymised data to be used for aggregating usage and ratings of tools which would then be made available to other participants, would you have agreed to this? Suppose you were to be given access to the*

aggregated data of other participants only if you agreed to share yours. Would this have changed your decision?"
This question was aimed at determining what proportion of the sample would be willing to share their anonymised data with other end-users while the follow-up question to those not willing to share their data, presented a hypothetical situation whereby the privilege of having access to the SMF would be conditionally granted to only those accepting to share their data. This would in turn help uncover whether the end-users would change their initial choice of not sharing data. Most of them (11 out of 15) answered that they would allow their anonymised data to be shared and the remaining end-users did not want their data to be shared. With the follow-up question, two among them believed that they would have agreed to share their data if that would have been the only way to have access to the SMF. A third end-user who had answered 'No' to the question and its follow-up voiced out that:

> *"If the data was being collected by default and shared…I wouldn't mind…But if explicitly asked, I would definitely say no!!!" (P19)*

Therefore, it can be observed that the use of shared data by SMFs in DBCIs would be welcomed by a vast majority of intervention participants provided some degree of anonymity was provided. The way consent is sought from intervention participants is also very important so as to ensure that they understand the benefits of sharing their data and the protection that the intervention would provide to their privacy.

Question 6: "*According to you, how could the 'Popular Tools' feature be improved?****"***
Most of the suggestions were related to the layout design of the SMF which had been kept deliberately simple so as to be consistent with the overall application's design. Referring to the descriptive text (see Figure 16.) explaining the popularity calculation, a few end-users (5 out of 15) were observed spending time and struggling to read it. They suggested that it should be shortened and simplified if possible as quoted from one end-user:

> *"shorter description at the top" (P1)*

The overall visual aspect of the feature and the mobile application in general with respect to the 'look and feel' was also among the most commented themes for this question. Referring to the overall aesthetics aspect of the application, several end-users expressed their desire to have a more visually pleasing application with one of them saying:

> *"I don't like the current design, I would prefer something more attractive" (P3)*

It was also suggested to make use of colours, graphics and videos instead of plain and static text by a few end-users quoted next:

"It could be improved (in) term(s) of usage,a better design or colors." (P19)

"Add(ing) some graphics will make it more interesting, maybe some videos too rather than just plain text." (P5)

"Ratings i.e. how many stars that users satisfy or unsatisfy with the features. Give users scores, badge or money when they complete each task and see which one is the best part or worst part" (P20)

Another suggestion to reduce the amount of clutter on the screen made by an end-user was to make the list items clickable instead of using the 'Launch' buttons. (see Figure 17):

"The button on the right-hand side could be removed. Instead it would be better to view the activity description by touching the text itself" (P15)

As described in the Observations section, many end-users (9 out of 15) failed to identify the 'Ratings' tab in the SMF and they were informed about it after completing the tasks assigned to them. Therefore, it was expected that some suggestions would refer to this aspect as evidenced by the following quote samples:

"Make the ratings tab clearly visible." (P8)

"Maybe make it slightly larger like tabs for usage and ratings." (P14)

These reiterate the importance for ensuring that all items are clearly laid out to maximise visibility to end-users and ensuring that the latter can differentiate between clickable and non-clickable items.

Another interesting suggestion made was the possibility of associating the SMF with groups of participants:

"There are going to be groups of users.so if the app knows my group-it should give higher weight to similar users" (P18)

Intervention participants belonging to a particular group would see a list of popular tools calculated by associated higher priorities/weights to the data aggregated from fellow group members but complemented with that of participants from other groups.

Question 7: "*Describe whether the availability of the 'Popular Tools' feature impacts on your use of the mobile application in general?"*

Most of the end-users (12 out of 15) believed that having the 'Popular Tools' SMF would have a positive effect on their use of the mobile application and thought that the SMF would encourage them to engage more with the application as quoted in the following sample responses:

"Maybe increase my usage a little bit" (P5)

"It promotes the use of the applications [sic] (tools)" (P19)

Their perceptions might have been based on the fact that the SMF displayed the different tools available along with their popularity and made it easy to access each tool from the ranked listing as an end-user mentioned:

"I suppose make it easy to access the tools" (P3)

A few end-users (3 out of 15) also mentioned that viewing the tools popularity based on other end-users' data might influence their own choice of tools to try in the interventions, with one quoted:

"my use may be influenced based on what other users are doing" (P12)

Two end-users described how it would be helpful for them as new users to explore the tools available in the intervention by trying out the tools that existing users have been using the most; hence accessing the tools through the SMF:

"to begin with, it would be the primary way I selected, until I had enough experience to have my own preferences" (P18)

"As I am a new user, it is useful to know what other people have used that I might (have) miss(ed) it" (P20)

However, one end-user mentioned that the SMF would not have any effect on his/her use of the application.

Based on the responses, it can be concluded that the vast majority among the end-users had the perception that the SMF would be beneficial for them in different ways as described and quoted above. As a result, the SMF can be perceived as having the potential to enhance user engagement in the intervention.

Question 8: "*Can you think of any other features similar to the 'Popular Tools' in the way that data from all participants are used in other mobile applications?"*

There were very limited responses from end-users about other features which like the 'Popular Tools' feature, could provide aggregated data for the benefit of users. One proposal made by two among them was about the introduction of a recommendation system whereby intervention users would receive tools suggestions based on the tools that their friends or other users in their groups have used:

"Collaborative recommendation system (Amazon, netflix). Google flu outbreak like prediction-weather or health prediction based on users movements" (P8)

"Lots of apps have simple recommender engines offering 'people who used this also used this options - amazon, etc" (P18)

Another idea that was proposed revolved around the sharing of data on social networks:

"Share on social media once (a) tool has been used" (P1)

Although only two feature suggestions were made, they were very relevant and feasible ones which could be taken on-board for the development of future SMFs.

Question 9: "*Are you engaged in any form of online social networks (e.g. Facebook, Twitter etc)?"*

In terms of Online Social Networks (OSNs), all the end-users were involved in at least one OSN. The majority of them were active on Facebook which was followed in terms of popularity by Twitter. Other OSNs used by the end-users included Renren, Tumblr and Livemocha. See Figure 23. for a detailed breakdown of this data. Their main activities were: keeping in touch with friends and relatives, sharing photos, arranging social activities and professional networking.

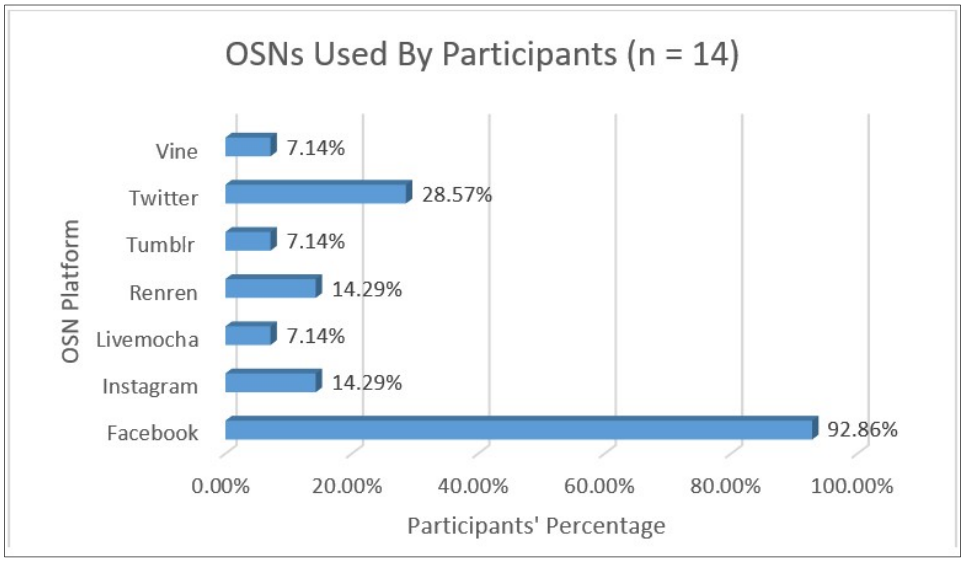


Figure 23. Chart of OSNs usage by the Participants

5.6.2.1 Summary of Key Findings

Although the application was a prototype, all the participants successfully managed to use the application to undertake a set of tasks provided to them. This is also evidenced through an above average SUS score for the included SMF's usability. A factor that might have also

contributed to usability aspect could have been the application's and the included SMF's simplicity which participants indicated an appreciation about.

In terms of their perception towards shared and aggregated data though SMFs, the participants felt that these were beneficial to them and encouraged them to engage more regularly and for longer periods with the application. Also, the majority had no issue about sharing their data provided that it was anonymised.

Although the amount of descriptive text was not excessive, some participants expressed their wish to have a more reduced amount of text. This could also be linked to the fact that a number of participants were non-native English speakers and who encountered some difficulty in understanding a few words used as labels for the application or within the accompanying evaluation instructions and questionnaires.

5.6.3 Thematic Analysis

After completing the SUS questionnaire, the intervention builders were interviewed using the list of questions in Appendix E as a general guide. The first two questions were based on the SMF prototype 'Popular Tools' while questions 3 and 4 were aimed at gathering further requirements and validating expectations from the intervention builders for future SMF prototypes that are being planned.

Thematic analysis was performed on the answers to question 1 and question 2 along with the general comments made about the current SMF prototype. The interviews were transcribed verbatim. This included getting the investigator familiarised with the transcripts by reading through them at least three times each; commonly referred to as immersion in the data. Six codes were initially generated based on the transcripts. These were then refined into four themes for a short thematic analysis. Table 12. shows the themes used along with a short description for each.

No.	Theme	Description
1	Usability	The usability aspects of the 'Popular Tools' feature in terms of ease of use, learnability, predictability, simplicity etc.
2	Perceived Usefulness and Impact	How the feature could be useful in different scenarios and the expected effect that the feature would have on users.
3	Issues and Suggested Improvements	Issues and difficulties that end-users might encounter as pointed out by the intervention builders with respect to the feature along with proposed improvements.
4	Future Usage	Scenarios where the intervention builders believed that they might use the feature for their future interventions.

Table 12. Code Descriptions for Intervention Builders Interviews

5.6.4.1 Results and Discussions

The results for each theme are reported below along with discussions.

Usability

Intervention builders unanimously voiced their appreciation of the prototype's usability. This is further evidenced by the mean SUS score of 91.25 which although based from a sample size (N = 6) below the recommended sample size (N >= 8) could be considered as reliable due to the low standard deviation (σ = 6.85) compared to the overall standard deviation (σ =16.28) when intervention builders were excluded from the sample (N=15).

The ease of use was one of the most common aspect that came up when they were asked about their general thought of the 'Popular Tools' feature. They also commented that the feature organised the information in a logical way; for example, the ordering of items in descending order which could enable participant to quickly find the most popular items. One intervention builder mentioned that she believed that the feature demonstrated a simplistic design which was much appreciated:

> *"Yeah I think this is very easy.; It couldn't be simpler and better designed, very good.; I really like it" (P9)*

The design's simplicity could be credited to the fact that the number of Graphical User Interface (GUI) elements on each screen was kept as low as possible (for example, using only few colours, displaying only the important buttons while making their functionalities obvious, etc).

Perceived Usefulness and Impact

Several scenarios were brought forward by the intervention builders to illustrate their perception of how the SMF could be useful to intervention builders and end-users

The 'Popular Tools' feature could help an end-user in exploring the different parts of an intervention, quickly by looking at what other end-users had been doing as two intervention builders were quoted:

> *"So, if they knew they wanted to go into something they were really familiar with, then they'd be using something they used often but if they felt they wanted something different from the app, its quite a good way of showing what else the app has got." (P11)*

> *"And I think also if you are going on it and you want to use it but you are not really sure where to start , its helpful to see what other people have done." (P9)*

Following up from the scenarios above, end-users having used different tools in an intervention and who happened to forget the name of one among them that he/she might want to re-use, could refer to his/her own usage data presented through the SMF as said by an intervention builder:

> *"For example it might be helpful if you've done, if there is one thing that you may like to use but maybe you forget what the name was or what it was called, that's a good way to find it again so a bit like history have." (P9)*

Several intervention builders said that end-users of DBCIs would be interested in what other end-users were doing and how well they were doing etc. Instead of simple curiosity, it was suggested that the main reason behind could be a belief that whatever was helpful for someone else might also be beneficial for oneself as an intervention builder described:

> *"I certainly think that people do seem interested in what other people think is a useful part of an intervention or of an app or anything. I think just because part of human nature is that people like to know what other people like to think about what's helpful, what's helped other people and they tend to...i think some people tend to associate things that have been helpful for other people as things that are potentially gonna be helful for them as well." (P21)*

This reasoning might be used by intervention builders as a strategy to motivate end-users to try different tools available in the intervention by providing them with data that has been manipulated to show specific tools as being popular to trigger an interest as mentioned by two among them:

> *"I think people will look at it and if they see that there is something that's very popular then they'd be more likely to click on it than if they were just using it then they might pick things that they liked. So, i think it would make a difference." (P10)*

> *"It could potentially, I think hmm with hmm [sic] showing the usage data and having the list of the different features that it has, people might be more likely to go through it...even (if) it wasn't useful for them, they would initially possibly be interested. So, I think that's quite useful..."(P16)*

Providing a ranked list of tools to show an intervention's tools popularity was considered as an appropriate way to provide data to end-users without them having to spend much time and effort in reading or having to go in depth:

> *"Yeah, I think it might be of most use to people who perhaps perceive that they don't have much time to be able to use the app; they might not want to sort drill through every aspect of it, they might want to skip straight to the things that they think are the important features which they may well be thinking they can pick up from what other people would have also." (P21)*

Based on the various perceived benefits to end-users, it was mentioned that this could help in maintaining a higher level of user engagement in the interventions through the use of the SMF which in turn would be beneficial for the whole intervention and the end-users themselves. In this context two intervention builders stated:

> *"I think it will help the usability and I think it will help the engagement in it…" (P9)*

> *"It helps them to keep engaged using the intervention tool as well because its quite interesting." (P16)*

The interviewees also highlighted the fact that based on the context and the type of intervention, there may be varying degree of usefulness. For example, end-users might find the SMF more useful in interventions having a large number of tools compared to the ones having only a few. Similarly, interventions whereby participants would be more inclined to believe what other end-users were doing would be useful for themselves would benefit the most from the SMF. Also, for a particular intervention, different participants might find the feature useful for different reasons which have been summarised above. But, in general, there was an agreement from all the intervention builders that the feature would be useful to have in DBCIs.

In terms of impact, the feature could possibly make a difference in the way end-users tried certain items/tools which was hinted in the comment that follows:

> *"I think people will look at it and if they see that there is something that's very popular then they'd be more likely to click on it than if they were just using it then they might pick things that they liked. So, i think it would make a difference." (P10)*

This was described in a scenario whereby intervention participants looking at the list of tools and saw one which was very popular; they would be more likely to try it. Therefore, it was suggested that the 'Popular Tools' feature might act as a reminder for participants to be aware of the tools available and encourage people to try a wider range among them. Also, participants might feel more motivated to make a change (by using one of the tools) when they would see other users choosing a particular tool. The possibility of enhancing user engagement for an intervention had also been mentioned by at least two intervention builders who believed that participants looking at the list of tools ranked by popularity would be more motivated to engage with the intervention over a longer period.

Issues and Suggested Improvements

Several minor user requirements issues were raised during the interviews along with related suggestions. While these were important for refining the prototype SMF, we have attempted to generalise them so that they could be applied to other future SMFs. The concerns and issues that the interviewees raised during the discussions have been grouped based on the section of the feature they were addressed at, along with the suggested improvements and the ways these could be generalised.

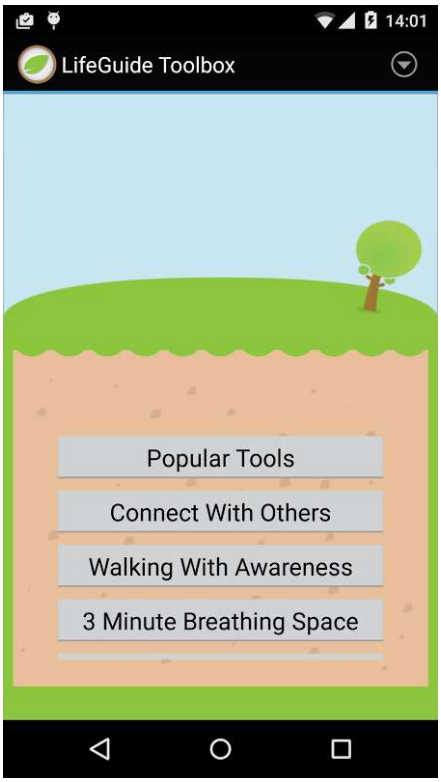


Figure 24. Screen Showing the Popular Tools Button

Popular Tools Button

The location of the 'Popular Tools' feature button (see Figure 24.) as mentioned by one intervention builder as not being clear:

> *"I am not sure…where the popular tools (feature) is…maybe under tools?...yep[sic]." (P10)*

But they correctly guessed that it would be located within the 'Tools' menu. Although all other intervention builders successfully located the SMF, the above-described situation raises the concern that properly locating SMFs within an intervention is important for ensuring visibility to end-users specially as the latter might not explicitly be informed about the SMFs in the interventions contrary to this evaluation. One option would be to empower intervention builders with the ability to re-position SMFs within their interventions through the intervention configurations as suggested by another intervention builder:

> *"I imagine that when people use the ubhave framework to make the app, they could organise the position, I imagine...so i think that flexibility is great, yeah." (P9)*

Viewing Preference Screen

The 'Popular Tools' first screen's title (see Figure 25.) which was "Data View Preference" was believed to be inconsistent with the 'Popular Tools' feature by one intervention builder whose view was that the current title with the word 'data' in it, was more geared towards a researcher or application developer rather than an intervention's end-user:

> *"Why does it say "data viewing preference" instead of pouplar tools? for a user rather than developer" (P11)*

Similarly, the descriptive text (as shown in Figure 16), providing end-users with details about how the popularity of tools were determined was deemed "quite a lot" by most interviewees. One of them pointed out that the language used in the text could cause the average user to struggle in understanding:

> *"I would change the language on here, so…I think the average person will struggle with that sentence so I would make this whole paragraph shorter and simpler" (P9)*

Another comment made during the interview with one of the intervention builders was about the labels used for providing participants with the option of viewing the list of popular tools based on their own data or based on all participants' data. They explained that intervention participants do not think of themselves as 'participants' but rather think of themselves as people:

> *"See, I would say, I would change that 'own data' to your data and all participants, I would change that to other people because participants they dont think of themselves as participants, they think of themselves as people." (P9)*

The issues described above highlights the importance of using non-technical words, reducing the length and simplifying instructions to end-users as far as possible. In these instances, however, the texts being referred to by the intervention builders would be normally entered through an authoring tool and would therefore be customisable which was important for enabling DBCIs to be adapted based on the contexts such as type of condition being addressed, level of education of the participants etc.

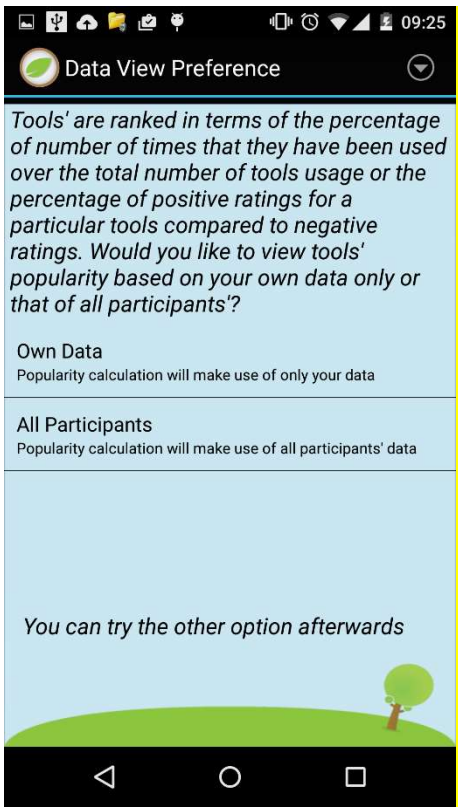


Figure 25. Viewing Preference Screen

The Popular Tools List

As described in the Observations and End-Users Sections, the issue regarding the 'Ratings Tab' (see Figure 26.) was also commented on by the intervention builders who pointed out that it was important to make the tabs more obvious through the use of a colour scheme for example:

> *"I didnt even notice that bit on the top,I would actually, is it possible to have to different tabs so, its obvious that that is one and you click on one and then*

> *its obvious that that is a grey box, you can click on it. Maybe do the color scheme, use different colors or something , I didnt even see that." (P9)*

While it was not obvious that the tab would be missed by a large portion of intervention participants at the time of design and development, in future SMFs careful and thorough user testing should be carried out to ensure that visibility of the different parts of the SMFs are maximised through the intelligent use of graphics and colours.

The current list of tools provided usage data in terms of number of uses and a percentage underneath each tool item. It was discussed about whether intervention participants would benefit from having both the number of uses and percentage for each tool or whether only the percentage would suffice. The argument being that with the number of uses, in cases where there were only a few participants, they could feel discouraged looking at the numbers whereas this information could easily be disguised when using percentages. So, in future SMFs, wherever aggregated data would be used, it should be determined whether a count, percentage or both would be the most beneficial. Also, in terms of percentages, in cases where there would be no requirement for high-precision, the values could be rounded off to the nearest integer as suggested by an intervention builder:

> *"With the percentages you could just say 25% instead of 25 point something, just round it up because, you know what i mean, because it's accurate and if you are just looking you wouldn't want that level of accuracy as a participant."(P10)*

The visual aspect of the list was also commented on by the intervention builder; one of whom mentioned that graphically representing the data through a kind of bar chart would convey the information faster and enable quick comparisons:

> *"... it'll be nice to be able to compare them directly, maybe in a bar-chart, or something. In a graphical representation." (P10)*

The ranking was also suggested to be made more obvious as the current ranks were indicated by numbers having the same font size as the tools' labels.

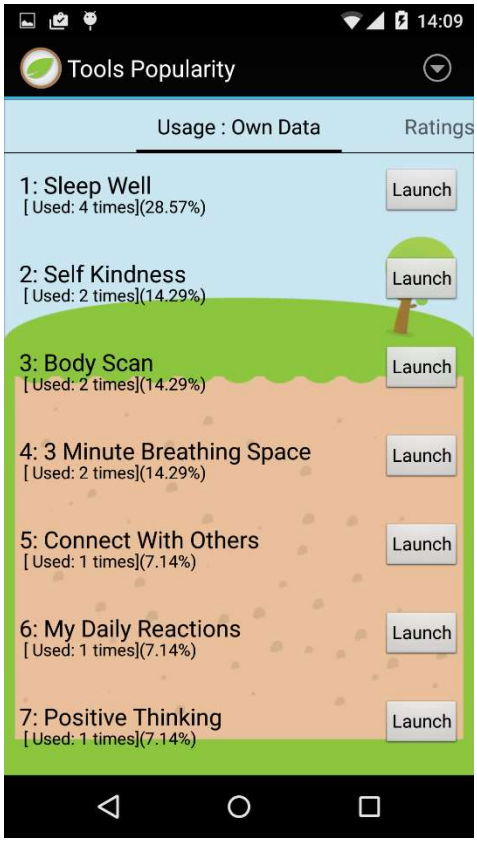


Figure 26. Popular Tools Listing

A concern raised during the interview of one of the intervention builders was the fact that the list would potentially be displaying a list of tools with zero or one hundred percent for all the tools in the list for the first intervention users. She suggested the possibility for intervention builders to be able to use some fabricated data for the first users:

> *"... obviously it would have to collect that data; So, for your very first participants there wouldn't be any data. Create some data initially...just to encourage them." (P11)*

Future SMFs having functionalities which rely on participants' data could face similar issues and therefore, during their design, care should be taken to incorporate mechanisms for intervention builders to assign default values to elements where data is originally not available.

Future Usage

All the interviewees believed that the 'Popular Tools' feature would be useful if integrated into their current and/or future DBCIs. A scenario described by one of the intervention builder involved the use of videos within an intervention:

> *"So as I said, the video, the example of the videos, and in fact we are now starting a new project to base on that intervention I made and we have been*

> *thinking of how can we ,how can we make people watch the videos, because they are so good and they take us so long to make and they are so expensive. And people like them but how can we get more people to actually look at it. So we were thinking of where to place it in a more prominent place, but having something like that would help, yeah." (P9)*

The intervention builder highlighted the fact that these videos cost them a lot of resources both financially and in terms of time but only ten percent of the participants were actually viewing them. From those ten percent however, all of them really liked the videos. She predicted that providing participants the ability to rate the videos and then using an adapted version of the 'Popular Tools' feature to instead show popular videos based on ratings would encourage other participants to view them as well. The listing of popular videos was also mentioned by a different intervention builder interviewed. A different situation that they believed the feature could be integrated was for tracking sessions and popular topics that participants are engaged in and found useful:

> *"Alright, like sessions, which could be similar to the tools. Popular sessions, popular topics, different sections of the website that people found useful maybe, yeah..." (P10)*

This would then encourage others to consider the popular topics as well for example. Another interviewee voiced his desire to have an adaptation of the feature to be used for listing popular interventions instead of tools:

> *"Potentially yeah, so, the intervention that I'm planning to do , it will will [sic] use other different interventions or chapters. for example, one of them is for physical activity, one of them is for using your medication, one of them is for psychological parts, you know...they are interventions in themselves. And part of them are tools, but they are all different parts of the interventions." (P17)*

The interviewee was planning to work on an intervention which would consist of several other interventions for people to choose from. An intervention builder described an intervention whereby participants would be encouraged to choose a 'lifestyle changer' and would have five different options for example, 'being more active', 'eating less' , etc. It was believed that showing to a participant what others have chosen would be interesting and could motivate them.

5.6.4 Chapter Conclusion

The strength, limitations and findings of this evaluation are described in the next sub-sections.

5.6.4.1 Strengths and Limitations

The evaluation enabled data to be collected about the SMF prototype from both end-users and digital intervention experts' perspectives. The analysis helps towards improving future SMFs that match both intervention experts' expectation and end-users' needs.

However, for ethical reasons, it was not possible to recruit at that point, existing participants in ongoing interventions using the LifeGuide ToolBox framework. But this minor limitation was expected to be offset by the input from intervention experts and the fact that the evaluation focused largely on the usability aspects for end-users.

5.6.4.2 Findings

Based on the evaluation undertaken, it can be concluded that the SMF prototyped, referred to as the 'Popular Tools' feature is above average in terms of usability when compared to other Graphical User Interfaces (GUIs). However, it should be noted that no data was available for smartphone application interfaces for comparison. During the quantitative analysis, it was also uncovered that the SUS questionnaire yielded significantly different results depending on whether participants were comfortable with the English language or not.

While the data gathering strategies differed when targeting end-users from that of intervention builders; the former through the use of open-ended and 'Yes/No' styled questions and the latter through semi-structured interviews, it was found that both groups' data could be corroborated and indeed, complemented each other.

Most of the evaluation participants agreed that the feature would be useful but in different ways. As far as social engagement was concerned, end-users were found to be inclined towards sharing their data to others as long as this was anonymised and that they would benefit from this. Having access to aggregate data was also thought to be a motivating factor for end-users and could potentially help towards prolonging their engagement with DBCIs.

There were several improvements that were suggested by the evaluation participants, most of which could be addressed by digital intervention builders through the intervention configuration file. But most importantly, this evaluation helped in the identification of important aspects that should be considered in the design of future SMFs.

While intervention builders favoured a simplistic design approach for SMFs, end-users tended to expect visually-pleasing interfaces. Therefore, in future SMFs, a proper balance between simplicity and aesthetics will have to be achieved but at the same time, ensuring that all components are clearly visible and accessible.

To maximise the SMFs visibility within digital intervention applications, providing intervention builders with the flexibility for determining the optimal location would be a good strategy to adopt since the structure of DBCIs would tend to differ from each other.

Seeking consent from end-users for sharing their anonymised data should be carefully planned into the SMFs while creating awareness about the benefits of doing so. They should also be re-assured about the protection of their privacy when using the SMFs.

The evaluation also showed that the clear majority of end-users tended to use at least one OSN platform. It could therefore be interpreted that they would be familiar with common SMFs prevalent on popular OSNs which when adapted for use within DBCIs would be straightforward for most end-users and would not require training.

SMFs could be combined to provide enhanced benefits to end-users in DBCIs. One example that came up during this evaluation was the use of the 'Popular Tools' feature within groups of participants sharing common attributes.

In general, this evaluation showed that there was definitely a place for generic and customisable SMFs in DBCIs. However, to gauge their real impact, wide-scale deployment, data gathering and analysis should be performed. This would help address the main limitations of the current study where a rather small sample size was used. Also, the end-users for this study consisted of university students who cannot be considered as a representative sample of real DBCIs participants which could in turn have introduced some bias in the data gathered although this was expected to have been mitigated by the contributions from intervention builders.

The SMF included had above average usability. Received feedback from participants helped in refinements that was done in the generic framework and authoring tool (See Chapter 6.)

Chapter 6. A Generic Framework For the Inclusion of Social Media Components in Behavioural Interventions

This chapter describes the design and implementation of a generic framework to build and include SMFs in behavioural interventions. This work took place in parallel with the development of a generic framework for the development of cross-platform mobile & web applications for behavioural interventions known as LifeGuide ToolBox. Through this work, we have also contributed in its development and testing but extended its functionality to include social media features and enhanced data management capabilities. The focus of our contribution has been related to the inclusion of social media features and the data management aspects.

6.1 Overview

In Chapter 5., the feasibility of incorporating SMFs in a mobile-based DBCI was evaluated along with the perceived usability of these features by end-users. The findings of the pilot experiments has been used in the current chapter to design and develop a generic framework capable of supporting the inclusion of SMFs. Based on the feedback from intervention builders who participated in the focus group study (See Chapter 3.), the research question "*How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?*" was formulated and mechanisms for addressing this have been investigated in the current chapter through an intervention authoring tool.

6.2 High Level Architecture

Similar to the design of the prototype, the generic framework consists of two main components, that is, the client and server, along with a third component in the form of an intervention editor. Figure 27. shows how they interact with each other in the generic framework.

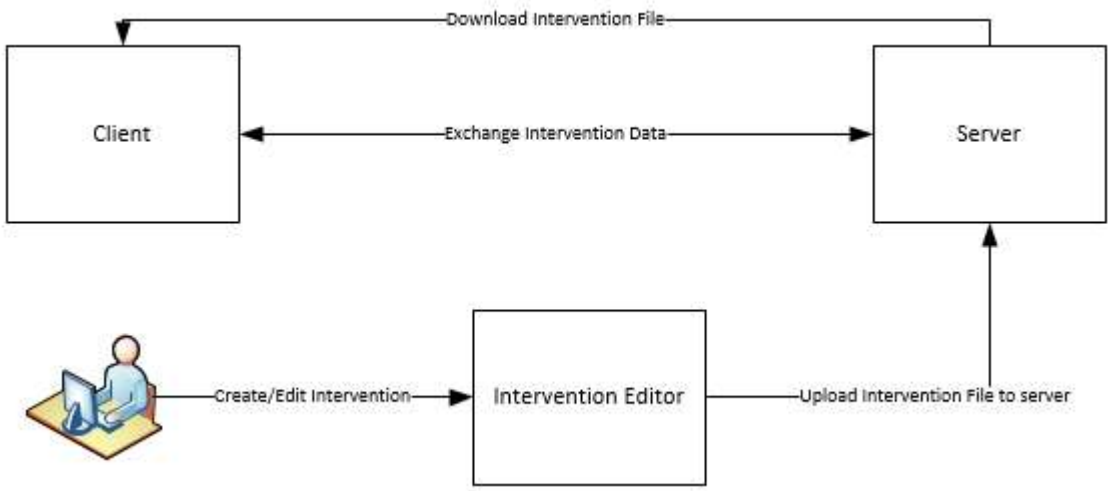


Figure 27. Interaction of Main Components

Intervention builders use a web-based Intervention Editor, which provides a graphical user interface to design and build an intervention. The outcome of this process is a file containing the details of the intervention in terms of structure, navigation and content. This file is then uploaded to a server. The client, which can be a smartphone running either Android or iOS with the application installed or a Web Browser, downloads the Intervention Configuration file during its first execution and it is rendered accordingly. During usage, the client then exchanges intervention data with the server (e.g. sending usage logs to the server; downloading aggregated data from the server).

The framework is depicted in more details in the Figure 28. with the three main parts, namely, Authoring, Server and Client expanded to show additional details.

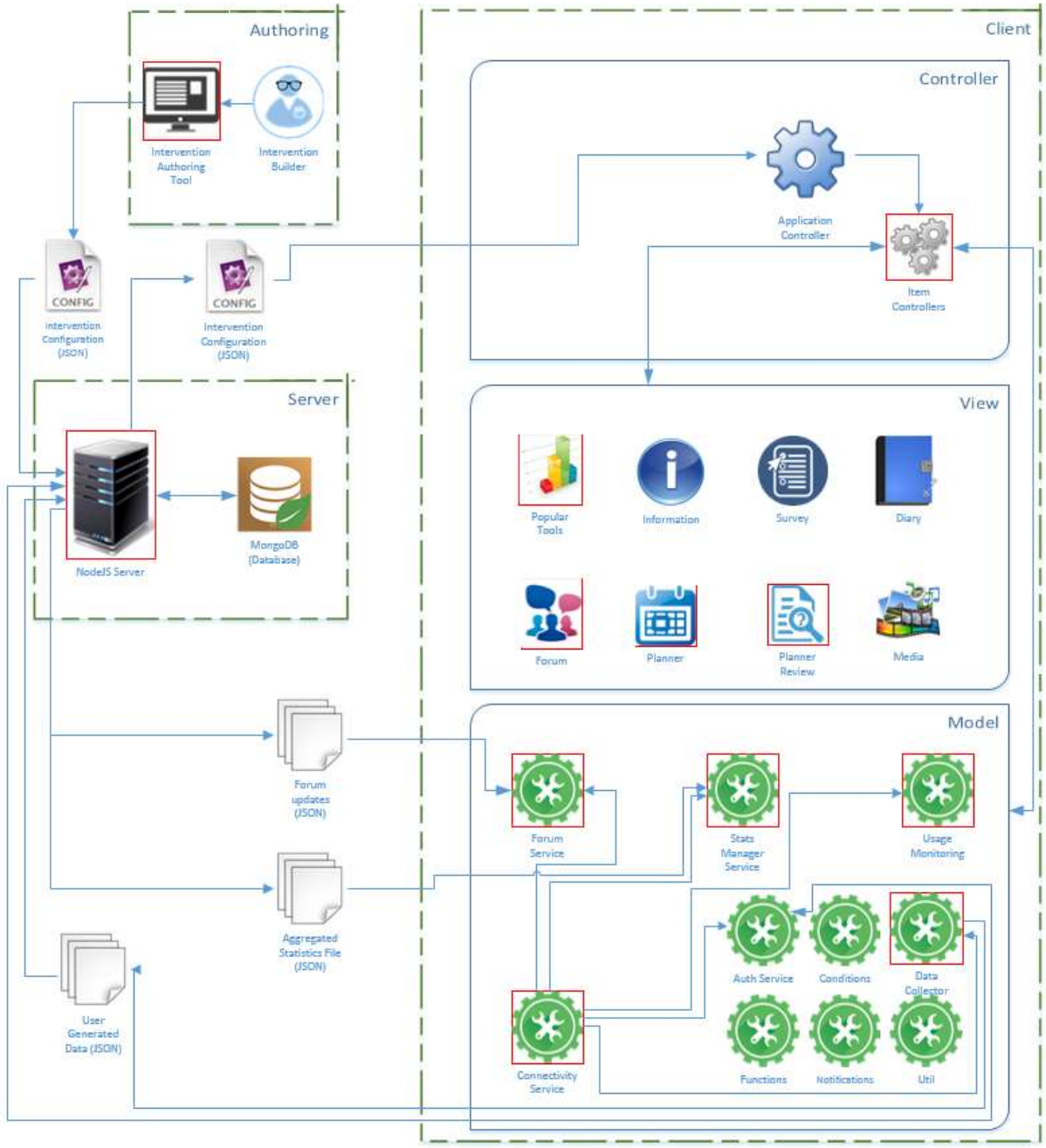


Figure 28. Remodelled Generic Framework Architecture

The inclusion of social media features in the LifeGuide Toolbox necessitated additional programming in many of the existing components for both the server / backend and the client side. The components which were extended or added are indicated with red borders.

An intervention builder uses the web-based authoring tool to create and customise a behavioural intervention. The authoring tool generates an Intervention Configuration file which is then uploaded to the server where it is stored in the database.

The first time that the client is executed, Internet access is required. The client authenticates with the server and downloads the appropriate Intervention Configuration file which is used to render the intervention the first time that the application is executed. The client is organised

based on the MVC architectural pattern with a main controller referred to as the Application controller. The latter manages the processing of the downloaded Configuration File and stores it on the device (e.g. an Android-based smart phone) so as to avoid re-downloading it in future instances that the application is executed. Based on the different sections accessed in the application, its corresponding controller is used which in turn selects the appropriate template (e.g. Forum, Information, Survey, etc) from the View and all the required components from the Model.

The Forum feature makes use of a Forum Controller and a Forum template along with the Forum Service. The latter's main role is to download regular updates from the server for the forum periodically or upon request and also manage the storing and sending of user-generated threads/comments to the server.

The Popular Tools feature makes use of the Statistics Controller and a Popular Tools template along with the Stats Manager Service which in turn regularly downloads updates from the server for the Popular Tools either periodically or upon request. These two options have been included to cater for the fact that smartphones might not always be connected to the Internet, in which case a request can be made once a connection is available or in case of using WiFi, updates can be periodical so as to have the latest data.

The Connectivity Service is responsible for monitoring Internet access from the device the application is running on. This service is used by other components to decide whether to send data to the server immediately or queue up data for batch transmission when Internet access becomes available.

The Usage Monitoring Service component tracks the different parts that the end-users access along with the corresponding time. The gathered usage data is uploaded periodically to the server where it is stored and used to produce aggregated statistics data of all end-users for use in the Popular Tools feature.

The Data Collector Service manages all data either created by end-users (e.g. posting of comments in the Forum) or generated by the application (e.g. usage data generated by the Usage Monitoring Service) which requires storage on and retrieval from the device and in cases where Internet Access was not available at its time of creation, requires batch uploads (from queues) to the server.

6.3 User Interface Design

The graphical user interface design for the two social media features, namely, the Forum and the Popular Tools feature are described in this section.

6.3.1 The Main Menu

After end-users successfully get authenticated, they are presented with the main menu for the specific intervention as shown as a wireframe diagram in Figure 29. which depicts an enhanced version of the HealthyMind application.

Figure 29. Wireframe of the Primary Screen With Main Menu for the Enhanced HealthyMind app

The logo for the application is positioned at the top of the screen and centred. Four buttons are available from the main menu, including the Forum and Popular Tools features. However, in future designs, if more than two SMFs would be included in an intervention, it is possible to move all the SMFs into a separate sub-menu.

Touching on the HealthyMind Forum or Popular Tools button will enable users to access the corresponding features. The two features' designs are presented in the next subsections.

6.3.2 The Forum Feature

The forum is organised hierarchically as follows:

- A forum consists of a fixed number of topics (determined by intervention builders)
- Each topic can have zero or more threads which can be created by users of type administrator and/or regular users depending on the forums settings.

- Each thread can have zero or more comments which can be posted by users of type administrator and/or regular users depending on the forums settings.

Figure 30. Wireframe showing the Forum Topics for the Enhanced HealthyMind App

The first screen for the forum displays a list of topics along with some details such their titles, descriptions, the number of threads that each topic contains along with the information about the creator of the latest thread for each topic as shown in Figure 30. Although the forum's content is regularly updated, if a user wishes to view the latest update, a Refresh button at the bottom-right of the screen provides this functionality. In case no Internet access is available when the user tries to refresh, a message to inform him/her about this is displayed in a pop-up type window.

Each topic and its details are surrounded by a border and touching anywhere within that border will open the next screen for that specific topic. To guide users, a triangular indicator on the right of each topic has been included.

Figure 31. Threads Within a Selected Topic

After the user has selected a topic, the next screen as shown in Figure 31. displays the topic's description at the top and a table of threads with their descriptions. A blue colour is used for the font of the Tread title and description to indicate that they are links. The number of comments and when the latest comment was posted and by whom are also shown in the next column.

At the bottom of the screen, there is a New Thread button which is displayed to users who are allowed to create new thread (dependent on the forum's settings). Selecting this button loads a form within the current screen as shown in Figure 32.

Figure 32. Creating a new Thread

The screen's content is scrollable; the form to create a new thread is displayed at the bottom of all the existing threads. The button to create a New Thread is replaced by a Cancel button which when selected, closes the form. Users can type the title and description of the new thread and touch the Create button. In case the forum does not require thread moderation, the new thread is immediately displayed among the list of existing threads; otherwise, a message informs the user that the thread creation has been successful and is pending moderation.

Figure 33. Posting a Comment on the Forum

Figure 34. Forum Comments

When a specific thread is selected, the list of comments for that thread is displayed in a table similar to the one for displaying threads as shown in Figure 34. Similarly, to add new a new comment, users can select the Add Comment button at the bottom of the screen which then displays a form for users to type in their comment on the same screen (see Figure 33.) For both screens (displaying threads and forums), in cases where there are more than ten entries, paging has been used so as to minimise excessive vertical scrolling.

6.3.3 The Popular Tools Feature

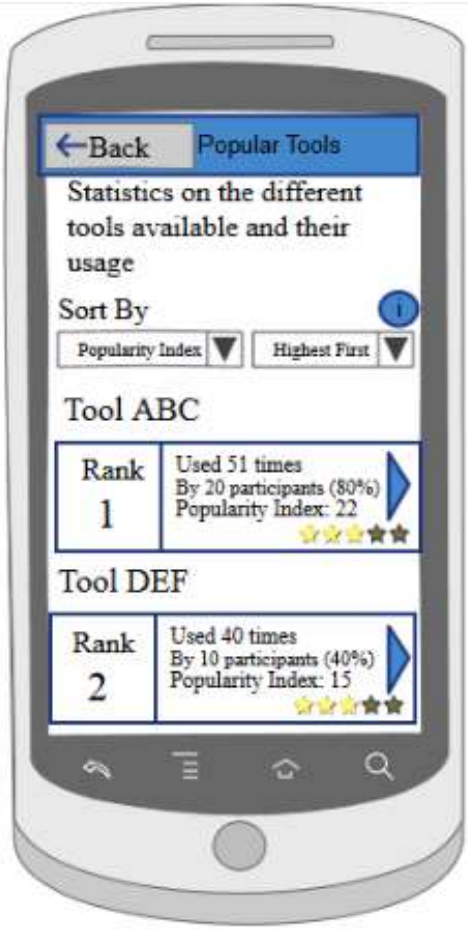


Figure 35. Popular Tools Feature

The Popular Tools design has been improved based on the findings of the evaluation of the pilot experiment described in Chapter 5. The simplified but feature-rich design shown in Figure 35., is expected to significantly improve users' experience.

The Popular Tools feature consist of a single screen with a short description at the top.

A sorting functionality enables users to select to either the Popularity Index (calculated based on the number of uses/access per participant) or Number of Participants and Highest First or Lowest First. The 'i' icon is used to provide more information to users about the sorting options should they wish to learn more.

In addition to the details displayed for each tool in terms of text and graphics (stars ratings), clicking on each tool redirects users to that specific tool.

6.4 Implementation Approach

A bottom-up approach was adopted for the implementation of the different components of the Popular Tools feature and the Forum. With a basic version of the generic framework already available, the two social media features were incrementally added along with empty stubs to enable early testing of the application.

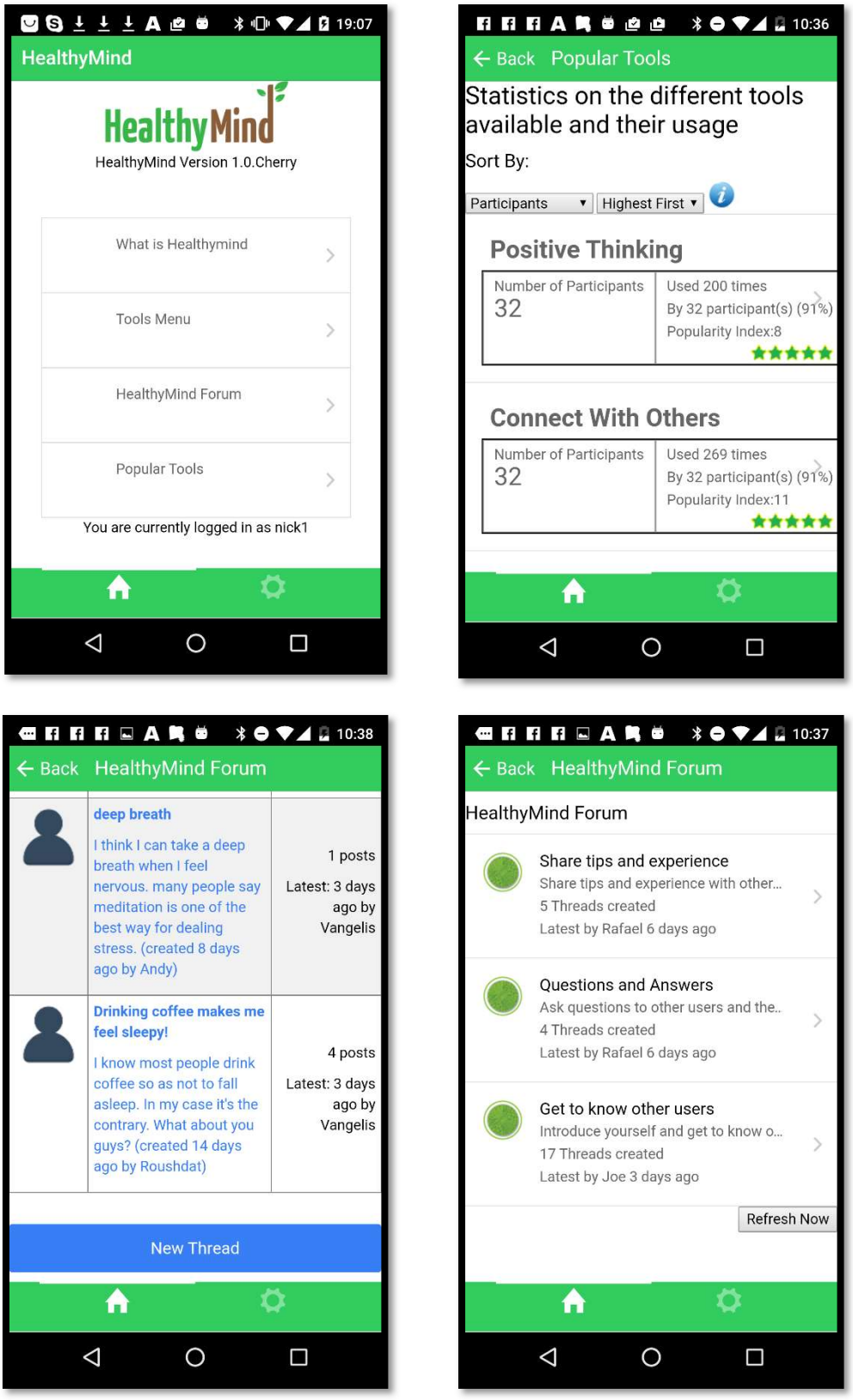


Figure 36. Screenshots of Enhanced HealthyMind App

Figure 36. Shows some screenshots for the application with SMFs. More screenshots for the implemented SMFs have been included in Appendix F.

6.4.1 Technologies Used

A number of technologies have been used in the development of the framework. The main motivation behind their selection was the possibility to develop cross-platform mobile and web-based application using the same framework. The client side used Ionic (version 1.3.1), an open-source SDK for developing hybrid mobile applications and Apache Cordova (version 6.1.0) which is a popular mobile application development framework which uses CSS, HTML and JavaScript.

The server made use of Node.js (version 6.0.0), an open-source cross-platform runtime environment using JavaScript and MongoDB (version 3.2.9), and an open-source cross-platform document-oriented database.

Data was transferred between the server and the client in the form of JavaScript Object Notation (JSON), an open-standard format for data-interchange.

6.5 Intervention Authoring Tool

In order to facilitate the inclusion along with the customisation of SMFs into behavioural interventions, the Generic Framework consist of a customisable client side and a server. Interventions are stored as JSON files on the server. These JSON files are in-turn generated through a user-friendly graphical interface known as the Intervention Authoring Tool.

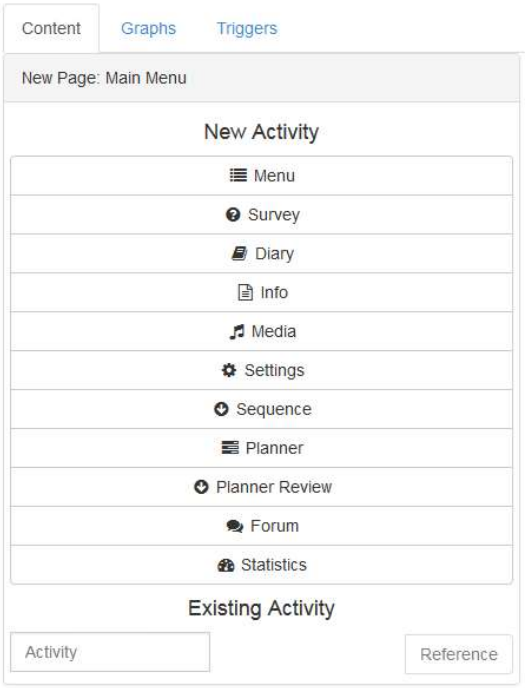


Figure 37. List of Items for Interventions in the Authoring Tool

For the purpose of this work, two SMFs, namely, an online forum and a statistical tool have been added to the Authoring Tool shown in Figure 37.

To include a Forum, the intervention builder clicks on it and can start filling a form with details for the forum such as “Topic Labels”, “Topic Description”, whether comments will require moderation before being visible to all users etc. The taxonomy of social media features presented in Chapter 5. can be used to organise the layout for adding future SMFs in the Editor. Therefore, instead of displaying individual SMFs, the different high-levels of SMFs will be displayed (e.g. Communication, Competitive, Activity Data Viewing, etc). When clicked, the sub-categories will then be displayed and thus not overwhelming intervention builders with options to choose from.

6.5.1 Including a Forum Through the Authoring Tool

After clicking on the Forum icon shown in Figure 37., the form in Figure 38. is displayed.

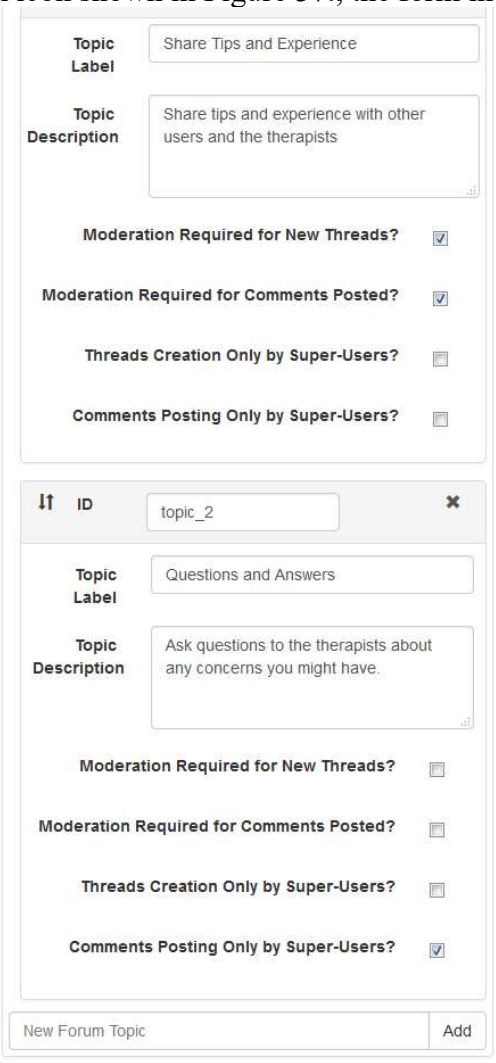


Figure 38. Form for Customising a Forum

The form enables the intervention builder to create as many topics as needed as well as configuring the settings for each thread and its corresponding forums.

Among the main details that can be customised, the topic’s label (title) and it description can be typed in the corresponding text-boxes.

Four check-boxes for each topic can then be checked based on the builder's requirements; checking the moderation options will prevent new threads from being visible to regular users without being moderated by a super-user (administrator); checking the Thread creation or comments posting only by super-users will hide the option for creating new thread or posting comments from regular users.

The forum is represented in JSON format for uploading to the server. The JSON snippet to represent the forum, its content and settings customisation is shown in Figure 39.


```
{
    "id": "HealthyMind_Forum",
    "type": "forum",
    "version": 1,
    "topics": [{
        "topicid": "topic_1",
        "topiclabel": "Share tips and experience",
        "topicdescription": "Share tips and experience with
                            other users and the therapists",
        "mod_thread_creation": "true",
        "mod_comment_posting": "true",
        "thread_expert_only": "false",
        "comment_expert_only": "false",
        "threads": []
    },
    {
        "topicid": "topic_2",
        "topiclabel": "Questions and Answers",
        "topicdescription": "Ask questions to the therapists
                            about any concerns you might have.",
        "mod_thread_creation": "false",
        "mod_comment_posting": "false",
        "thread_expert_only": "false",
        "comment_expert_only": "true",
        "threads": []
    }]
}
```


Figure 39. JSON Snippet Generated to Represent the Customised Forum

6.5.2 Including a Statistics Item (e.g. Popular Tools) through the Authoring Tool

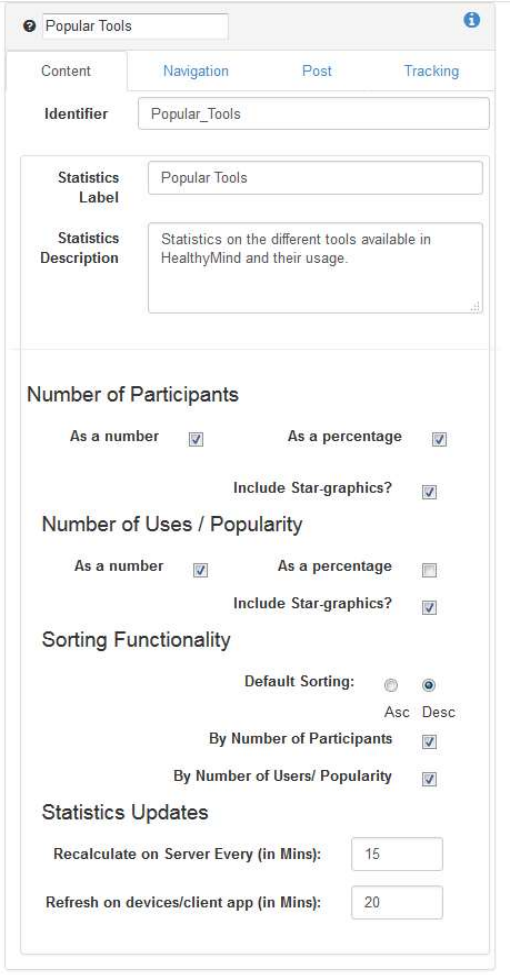


Figure 40. Form for Customising a Statistics Item

The Popular Tools feature is an example of a Statistics Item created in the Authoring Tool. Once selected, the form in Figure 40. is displayed. The intervention builder can provide a title and a description for the item. The different aggregated data options and whether to include the data as numbers or percentages, can be selected as required along with the default sorting order. As the need for the interval to recalculate the aggregated data will vary from intervention to intervention, this periodic interval can be specified in minutes.

The Statistics item is represented in JSON format for uploading to the server. The JSON snippet to represent the Popular Tools, its content and settings customisation is shown in Figure 41.

```
{
    "id": "Popular_Tools",
    "type": "statistics",
    "label": "Popular Tools",
    "content": {
        "description": "Statistics on the different tools available
                        in HealthyMind and their usage",
        "num_participants_as_number": true,
        "num_participants_as_percentage": true,
        "num_participants_star": true,
        "num_uses_as_number": true,
        "num_uses_as_percentage": false,
        "num_uses_star": true,
        "default_sorting": "desc",
        "sort_include_num_participants": true,
        "sort_include_num_uses": true,
        "server_recalculation":15,
        "client_refresh":20
    }
}
```


Figure 41. JSON Snippet Generated to Represent the Statistics Item (Popular Tools)

6.5.3 Tracking Access to Different Sections of an Intervention

For the Statistics items to function, they require data about user access to selected items/sections of an intervention to be tracked. The Authoring Tool has been modified to include a 'Tracking' tab for all items created in the intervention. This will flag all items that needs to be tracked by the Usage Monitoring Service.


```
{
    "id": "Connect_With_Others",
    "label": "Connect With Others",
    "type": "sequence",
    "tracked": true,
    "client_display": true,
    "statistics_item_id": "Popular_Tools",
    "content": {
        "items": [{
```


Figure 42. JSON Snippet Generated to Represent the Tracking Settings

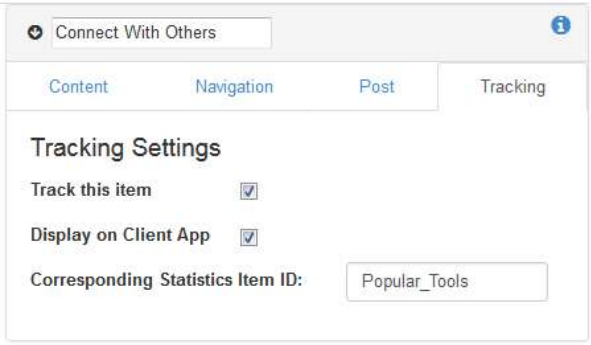


Figure 43. Form for Customising Tracking Options

Once opened, the Tracking tab provides the intervention builder with a pair of checkboxes and a text box as shown in Figure 43. The builder can then choose whether to track that specific item which will cause the client application to send tracking data back to the server for analysis which can be used both for analysis and displayed as statistics / aggregated data to end-users. Since it might not necessarily be desirable to display this tracking data to end-users, not selecting the second checkbox will prevent this. The text box content is optional in case only one statistical item is included in an intervention. However, if multiple such items are present in an intervention, then their corresponding IDs need to be typed. The tracking option is represented in JSON format as shown in Figure 42.

6.6 Chapter Conclusion

Two complementary components forming part of a generic framework have been reported in the current chapter, namely, an intervention authoring tool and a generic mobile-based application development framework for creating DBCIs. The research question "*How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?"* could potentially be addressed through the generic framework developed and reported. Its subsequent evaluation has been undertaken and reported in Chapter 7.

Chapter 7. Evaluation of Social Media Features in a Behavioural Intervention

This chapter presents a study for evaluating end-users' perceptions of SMFs included in behavioural interventions and explores their usability factors. The intervention used for this study is based on the extended LifeGuide Toolbox platform for building behavioural interventions presented in Chapter 6. along with the mobile application developed.

7.1 Overview

A generic framework for the inclusion of SMFs in DBCIs was developed and presented in Chapter 6. The current chapter presents a study conducted to evaluate end-users' or participants' perceptions of social media features included in behavioural interventions and explores their usability factors. The intervention authoring tool which enables builders to incorporate SMFs into DBCIs is also evaluated. An existing intervention known as "HealthyMind" [127] has been recreated and extended with SMFs using the generic framework and its components reported in Chapter 6, including the authoring tool. The intervention incorporated two SMFs, namely poll and forum, that were found to be among the most desirables according to the focus group study that saw the participation of intervention builders (See Chapter 3.).

7.2 Motivation

While the pilot experiment presented in Chapter 5. enabled us to verify the feasibility of including an SMF through a generic framework along with a brief insight into usability issues faced by participants, it was not conducted in a behavioural intervention style; that is, participants were given a mobile phone with the application already pre-installed and were requested to use it in front of the experimenter for a few minutes only. Furthermore, based on our systematic literature review, it was found that communication-based SMFs, especially online forums, were the most included feature.

The issues raised from the pilot experiment were addressed in the design and implementation of the SMFs used in this study. Therefore, an improved version of the 'Popular Tools' feature has been included along with an online forum as described in Chapter 6. This study will help demonstrate that SMFs can be included in behavioural interventions by intervention builders without computer programming skills with the features maintaining good usability standards for regular users and have the potential to have positive effects on them.

7.3 Methodology

This section describes the methodology adopted for this study.

7.3.1 Design

The application used for the study was pilot tested for two days by two independent individuals to identify issues in terms of functionality and wording. Similarly, the post-study questionnaire was validated by the same individuals who were not participants in the study. As a result, in a few cases some sentences were rephrased in both the application and the questionnaire.

The study was run over a period of two weeks with participants randomly assigned to either Group A or Group B while maintaining gender balance during this process. Group A was given access to a version of the application with the SMFs included for the first week while these features were removed in the second version of the application in week 2. Group B was given access to the SMFs in the second week but not in week 1. This was intended to mitigate the effect of participants trying specific SMF as part of their initial enthusiasm to try different features only at the beginning of the experiment

The Authoring Tool presented in the previous chapter was evaluated by requesting intervention builders to use it to undertake a set of tasks (see Appendix J).

7.3.2 Sampling

For the enhanced HealthyMind intervention, the participants were all healthy students at the University of Southampton and aged 18 years or over. Posters with the contact detail of the investigator advertising the experiment were posted in several locations across the University of Southampton campus and on Facebook groups. Those who expressed interest in participating were emailed an information sheet containing more details about the experiment along with a consent form.

Participants for evaluating The Authoring Tool were recruited by emailing all the Intervention Builders who participated in our focus groups studies.

7.3.3 Inclusion / Exclusion Criteria

For the enhanced HealthyMind intervention, all participants had to own Smartphones running Android with access to the Internet via their smartphones at least once a day.

For the Authoring Tool, all participants must have been an experienced intervention builder.

7.3.4 Procedure

Enhanced HealthyMind Intervention

After contacting the investigator about their interest to participate, participants were provided with an information sheet and were verbally briefed about the experiment to ensure that they understand what is expected from them. Participants were then given printed consent forms to sign.

The mobile application uploaded on the Google Play platform and a web link was provided to the participants to download and install it on their phones. This link was different for Group A

and B. Each participant was provided with a username-password pair and were required to login to start using the application

Both Group A and Group B used their respective version of the application for one week and at the end of week 1, they were provided with new web links to install the other version of the application.

At the end of the two weeks experiment, all participants were requested to fill in an online questionnaire (see Appendix G). After submission of the online questionnaire, they were requested to contact the research to be interviewed (see Appendix H for a list of questions used in the interview) and debriefed.

Authoring Tool

After agreeing to participate in the study by email, each participant was invited to attend a 30 minutes session.

The participant was then be given a printed consent form to sign.

A laptop was provided to the participant which had the web-based Authoring Tool already opened.

The participant was then provided with a Task list (see Appendix J) and requested to undertake each task on the laptop while thinking aloud. The participant was also encouraged to ask any questions during this process.

After completing the task list, an intervention was shown to the participant on a mobile phone to help get an idea how the intervention would look like once converted into a mobile application.

A post-experiment questionnaire was then provided to the participant to fill in (see Appendix K).

The participant was then debriefed verbally by the researcher and provided with contact details (phone number and email address) in case they have any further questions.

7.4 Results (Enhanced HealthyMind Intervention)

A total of forty-three individuals showed interest for participating in the study. Table 13. shows how they first found information about the study.

	Facebook	**Poster**	**Word of Mouth**	**Total**
Participants N (%)	28 (63.6%)	5 (11.4%)	10 (5%)	44 (100%)

Table 13. Recruited participants broken down by how they found out about the study

However, after providing further details on the study and asking their consent, a number of participants dropped out (two due to time constraints and for a further seven there was no further communication). We received consents from 35 participants (female: N=16 (45.7%). Two groups were formed with the 35 participants with participants randomly assigned to either Group A or Group B while ensuring that the gender balance was maintained during the allocation. The sample size for the two groups are detailed in Table 14.

Groups	Started Study	End of First Week	End of Second Week	Submitted Post-Study Questionnaire	Interviewed
Group A	N= 18 [9 females (50%)]	N=17 [9 females (52.9%)]	N=15 [8 females (53.3%)]	N=15 [8 females (53.3%)]	N=15 [8 females (53.3%)]
Group B	N=17 [8 females (47.05%)]	N=13 [6 females (46.2%)]	N=12 [5 females (41.7%)]	N=12 [5 females (41.7%)]	N=11 [4 females (36.4%)]
Combined	N=35 [17 females (48.6%)]	N=30 [15 females (50%)]	N=27 [13 females (48.1%)]	N=27 [13 females (48.1%)]	N=26 [12 females (46.2%)]

Table 14. Intervention Arms

At the end of the first week, it was found that a total of five participants had stopped using the application and a total of 8 participants had stop using the app during either the first week or second week of the study. Therefore, a dropout rate of 22.9% was observed during the course of this experiment and there were not much difference gender-wise in terms of total drop out (male: 22.2%; female: 23.5%). However, the dropout rate was higher in Group B (29.4%) than in Group A (16.7%) at the end of the experiment upon submission of the post-study questionnaire. While it was initially planned to interview a smaller sample of participants who had completed the study, we successfully managed to conduct interviews for all but one participant, who indicated availability constraints.

7.4.1 Quantitative Analysis

Perceived ease of use and helpfulness of the mobile application

Participants were asked through the questionnaire to indicate the extent to which they found the application helpful and easy to use. The responses are shown in Figure 44.

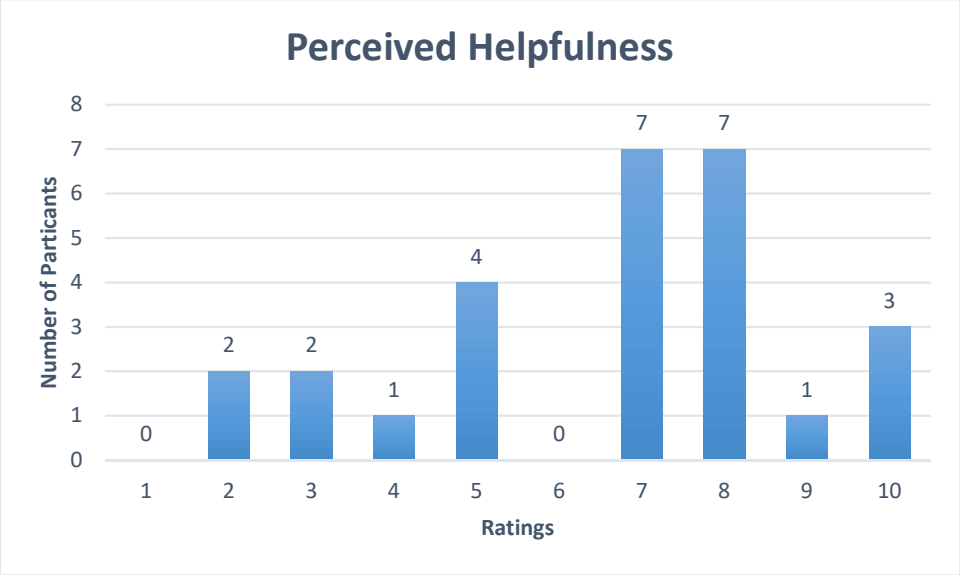


Figure 44. HealthyMind Application's Perceived Helpfulness

The majority of participants (N=18) perceived the application as being helpful with three "Strongly" agreeing that it was indeed helpful. The ease of use of the application was more strongly perceived was shown by the higher number of participants rating the app between (6-10) as shown in Figure 45.

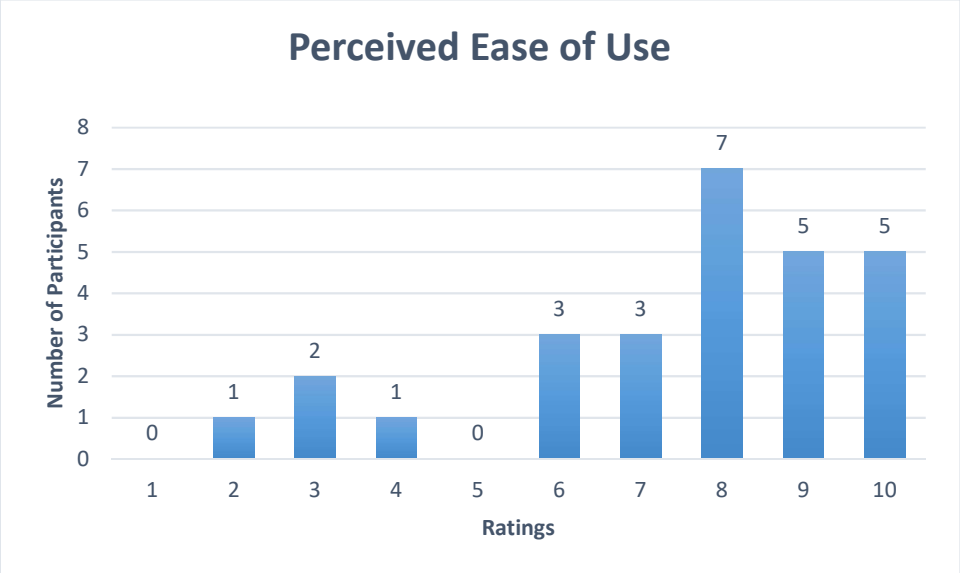


Figure 45. HealthyMind Application's Perceived Ease of Use

The Forum

All the participants who completed the study accessed the forum at least once. Indeed, it was accessed a total of 379 times by the participants over the two-week period which was an average of 14 times per participant.

A total of nineteen participants (66.7%) indicated that they either created a thread or posted a comment on the forum out of which nine were females (47.4%). Out of these active participants, sixteen created a thread to introduce themselves in the forum. This meant that nine

participants (33.3%) were most probably passive forum users who only read the thread descriptions and comments posted based on the access log data collected.

52% of the participants who responded to the questionnaire preferred the mobile application with the Online Forum feature, while for the remaining ones, they felt that it made no difference whether this feature was included or not. However, at least 66.7% of the participants actively participated on the forum by at least creating a thread or posting a comment. When asked whether they found the forum to be helpful, 63% of them responded positively. The close percentages between participants who were active on the forum and those who found it useful could possibly indicate some correlations.

In order to gauge the perception of a range of common feelings experienced by users of social media features when these are included in behavioural interventions as were found in out systematic review, the participants were asked to rate how strongly they agreed or disagreed with respect to statements describing the following feelings: **Positive feelings:** curiosity, happiness, motivation, supported and satisfaction; **Negative feelings:** anxiety, discouragement and embarrassment. Table 15. shows the distribution of responses.

	Curiosity	**Happiness**	**Motivation**	**Support**	**Satisfaction**
1 (Strongly Disagree)	0% (N = 0)	0%	0% (N=0)	0% (N=0)	3.70% (N=1)
2	7.40% (N = 2)	7.40% (N=2)	14.80% (N=4)	14.80% (N=4)	11.10% (N=3)
3	7.40% (N = 2)	14.80% (N=4)	3.70% (N=1)	3.70% (N=1)	7.40% (N=2)
4	3.70% (N = 1)	7.40% (N=2)	3.70% (N=1)	0% (N=0)	0% (N=0)
5	22.20% (N = 6)	18.50% (N=5)	22.20% (N=6)	18.50% (N=5)	25.90% (N=7)
6	0% (N = 0)	7.40% (N=2)	14.80% (N=4)	11.10% (N=3)	18.50% (N=5)
7	22.20% (N = 6)	14.80% (N=4)	3.70% (N=1)	18.50% (N=5)	3.70% (N=1)
8	14.80% (N = 4)	14.80% (N=4)	11.10% (N=3)	11.10% (N=3)	7.40% (N=2)
9	14.80% (N = 4)	7.40% (N=2)	14.80% (N=4)	11.10% (N=3)	11.10% (N=3)
10 (Strongly Agree)	7.40% (N = 2)	7.40% (N=2)	11.10% (N=3)	11.10% (N=3)	11.10% (N=3)

Table 15. Positive Feelings Towards Using the Forum

The positive feeling with the highest percentages in terms of agreement (scored 6 and above) was “perceived support” (63%) followed by curiosity (59%) , motivation (56%) and finally happiness (52%).

	Anxious	Discouraged	Embarrassed
1 (Strongly Disagree)	25.90% (N=7)	40.70%(N=11)	37% (N=10)
2	11.10% (N=3)	11.10%(N=3)	18.50% (N=5)
3	14.80% (N=4)	18.50%(N=5)	3.70% (N=1)
4	0% (N=0)	3.70%(N=1)	0% (N=0)
5	14.80% (N=4)	14.80%(N=4)	18.50% (N=5)
6	11.10% (N=3)	3.70%(N=1)	7.40% (N=2)
7	7.40% (N=2)	0%(N=0)	0% (N=0)
8	3.70% (N=1)	0%(N=0)	7.40% (N=2)
9	3.70% (N=1)	7.40%(N=2)	7.40% (N=2)
10 (Strongly Agree)	7.40% (N=2)	0%(N=0)	0% (N=0)

Table 16. Negative Feelings Towards Using the Forum

Most participants disagreed with all the three negative feelings statements with 88.9% of participants disagreeing with the feeling of discouragement, 77.8% for the feeling of embarrassment and 66.6% for anxiety feelings as shown in Table 16.

The SUS Score for Usability for the forum was 72.3 indicating an above average ease of use.

Popular Tools Usage

Twenty-five participants (92.6%) accessed the Popular Tools feature at least once during the one-week period that it was made available to them. This feature was accessed a total of 139 times during the two-week experiment and which was an average of 6 times per participants. However, some participants accessed the feature multiple times in a single day. Therefore, in terms of days, the feature was accessed on average on two different days by participants.

When asked whether they preferred using the mobile application with the Popular Tools included, an equal number of participants either preferred the feature to be included or found that it made no difference for them (N=12) while a few participants (N=3) indicated that they would prefer not having this feature. 63% of the participants (N=17) found the 'Popular Tools' feature to be helpful.

	Curiosity	Happiness	Motivation	Support	Satisfaction
1 (Strongly Disagree)	11.10% (N=3)	7.40% (N=2)	7.40% (N=2)	11.10% (N=3)	7.40% (N=2)
2	3.70% (N=1)	14.80% (N=4)	7.40% (N=2)	11.10% (N=3)	7.40% (N=2)
3	11.10% (N=3)	7.40% (N=2)	3.70% (N=1)	3.70% (N=1)	7.40% (N=2)
4	3.70% (N=1)	3.70% (N=1)	11.10% (N=3)	7.40% (N=2)	14.80% (N=4)
5	25.90% (N=7)	18.50% (N=5)	22.20% (N=6)	22.20% (N=6)	29.60% (N=8)
6	7.40% (N=2)	3.70% (N=1)	3.70% (N=1)	14.80% (N=4)	7.40% (N=2)
7	18.50% (N=5)	14.80% (N=4)	7.40% (N=2)	3.70% (N=1)	0% (N=0)
8	3.70% (N=1)	11.10% (N=3)	18.50% (N=5)	11.10% (N=3)	7.40% (N=2)
9	11.10% (N=3)	11.10% (N=3)	11.10% (N=3)	7.40% (N=2)	11.10% (N=3)
10 (Strongly Agree)	3.70% (N=1)	7.40% (N=2)	7.40% (N=2)	7.40% (N=2)	7.40% (N=2)

Table 17.Positive Feelings Towards Using the Popular Tools Feature

48% of the participants indicated that the 'Popular Tools' feature created a perception of happiness and motivated them. This was followed by curiosity and support (44% each). Perception of satisfaction had the lowest percentage of participants responding positively with 33% as shown in Table 17.

	Anxious	Discouraged	Embarrassed
1 (Strongly Disagree)	37% (N=10)	44.40% (N=12)	44.40% (N=12)
2	18.50% (N=5)	14.80% (N=4)	3.70% (N=1)
3	7.40% (N=2)	0% (N=0)	3.70% (N=1)
4	3.70% (N=1)	0% (N=0)	7.40% (N=2)
5	18.50% (N=5)	29.60% (N=8)	22.20% (N=6)
6	0% (N=0)	7.40% (N=2)	7.40% (N=2)
7	7.40% (N=2)	0% (N=0)	3.70% (N=1)
8	3.70% (N=1)	3.70% (N=1)	3.70% (N=1)
9	3.70% (N=1)	0% (N=0)	3.70% (N=1)
10 (Strongly Agree)	0% (N=0)	0% (N=0)	0% (N=0)

Table 18.Negative Feelings Towards Using the Popular Tools Feature

Most participants disagreed that the three negative feelings were perceived by them when using the Popular Tools feature as shown in Table 18. with more than 80% on them disagreeing for each.

The SUS Score for Usability for the forum component was 72.2 indicating an above average ease of use.

When asked how likely the participants would be to continue using the application after the study end, 59.2% of the participants responded positively as shown in Figure 46. This was also confirmed during the interview sessions afterwards.

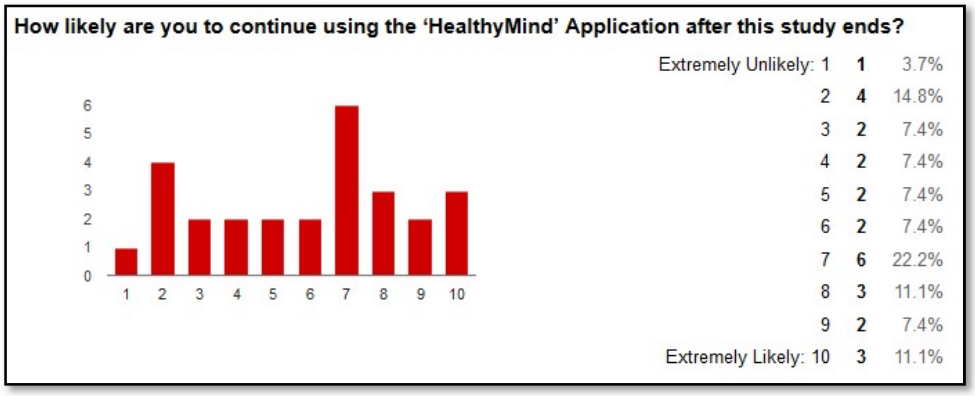


Figure 46. Likeliness to Continue Using HealthyMind

Participants were asked to rank social media features that they would have desired in the HealthyMind application with the ranking data shown in Table 19.:

	Live Chatroom	Sharing on OSN	Own Profile with picture/avatar	View Other Participants Profile	Social Notifications
1. Most Desired	40.7%(N=11)	11.1%(N=3)	14.8%(N=4)	7.4%(N=2)	25.9%(N=7)
2.	14.8%(N=4)	18.5%(N=5)	14.8%(N=4)	37.0%(N=10)	14.8%(N=4)
3.	3.7%(N=1)	7.4%(N=2)	48.1%(N=13)	22.2%(N=6)	18.5%(N=5)
4.	7.4%(N=2)	37.0%(N=10)	18.5%(N=5)	22.2%(N=6)	14.8%(N=4)
5. Least Desired	33.3%(N=9)	25.9%(N=7)	3.7%(N=1)	11.1%(N=3)	25.9%(N=7)

Table 19. Desirable Social Media Features Ranked by Participants

The most desired SMF was Live Chatroom (40.7%) followed by the ability to view other participants profile (37%). However, it should be noted that Live Chatroom was also among the least desired feature by 33.3% of the participants.

7.4.2 Qualitative Analysis

After completing the post-study questionnaires, the participants were invited for a short interview session in order to gather qualitative data through follow-up questions based on the responses provided in the questionnaires (see Appendix H for the list of questions used).

A total of twenty-six participants out of the twenty-seven who completed the study (96.3%) were interviewed and audio recorded. The recordings were then transcribed and added to the corresponding questionnaire responses. The data was then thematically analysed along with the responses from the open-ended questions from the questionnaire which in turn yielded the following three themes:

1. Ease of use
2. Motivating factors
3. Concerns and Suggested Improvements

Ease of use

This theme is about how the participants' perception with respect to how easy it was to actually use the application with an emphasis on the two social media features included, namely the 'forum' and the 'popular tools'. All the participants interviewed found it relatively easy to use

the application, including its social media features as stated by several participants who said things similar to the one quoted below:

> *"I think it was super easy; It was very easy (to use) because everything was divided into sections and you just click into the sections…"(P9)*

During the design and development of the intervention's application, emphasis was laid upon simplicity and ease of access so as to avoid burdening users with any training requirement or the necessity of user manual. These requirements were confirmed through the interview with statements from participants such as the ones below with one participant comparing its simplicity with the task of checking one's email:

> *"I do find it easy to use; any person able to read an email should be able to use it quite easily. It was quite straightforward" (P14)*

> *"I thought it was nice and clean hmm [sic] very clear, very easy to access" (P12)*

Also, diligent care was taken to avoid overloading users with information about the social media tools' usage by making them intuitive. In fact, the forum itself was being used by users who had some minor difficulties with other sections of the application to request for help and advice from peers. At least a few participants had some minor difficulties in using the application which was related to the graphical user interface, more specifically, the placement of buttons for navigation. While there are no specific standards for these elements at the moment among mobile application developers, many applications tend to choose the bottom area of the screens for their placement and in our application, these were placed at the top. However, it took a very short span of time for the users to get familiar with this aspect as three participants were quoted saying:

> *"In the beginning, it was a bit difficult (to use the application) due to the placement of the (navigation) buttons." (P13)*

> *"...I didn't know (that) I had to click 'next' but then I discovered that." (P15)*

> *"In the first place, I think it is [sic] relatively complex but after two minutes I was ok (using it)." (P4)*

While trying to balance simplicity and intuitiveness, with the amount of information provided to users, it seemed that the 'popular tools' feature appeared to be slightly more complex to understand and operate by users as quoted from a participant:

"(The popular tools) was somewhat slightly confusing but I did get the gist of it….a lot of the apps I was already using (had something) similar to the popular tools (feature)." (P18)

Based on the interviewees' responses, it was clear that they found the application to be easy to use despite a few minor hurdles at the beginning for a few among them.

Motivating Factors

The participants were asked about the different aspects or circumstances that motivated them to engage with the social media features included in the intervention and also in some cases that would have reinforced their engagements with these features. Most participants reiterated that the application's simplicity and ease of use as covered in the previous theme, contributed in encouraging them to use the social media features. The two social media features included in the interventions were associated with distinct motivating factors.

The forum was considered as a place for obtaining advice, including suggestions to use particular tools available in the intervention as a participant was quoted saying:

> *"Something you think it's best for you but someone tells you other thing (on the forum) and you try it, it may be of benefit to you." (P10)*

Some participants voiced out that they would have been posting more comments in the forum if there were more 'lead comments' or more responses to the comments from other participants to their own post:

> *"I guess it would be great if there was[sic] already existent comments in the forum, like give people an example." (P11)*

> *"If some people comment[sic] on my post, there would be more interactions" (P4)*

A few participants mentioned that they would have been more inclined to comment in case that they knew the other participants better and felt that they were interested to interact with them or had things in common. One participant said that sharing of the different activities in the forum made one more inclined interact with others on a regular basis. These can be understood through the following quotes:

> *"If I knew them (the other participants), then yeah, but in case I don't even know whether they care about my things, so I just prefer not to express (myself on the forum)." (P9)*

> *"If I know someone before (the intervention), and then he/she is participating in the forum, then we could have something in common and we are probably more sharable."(P3)*

> *"(If) other users see my activities, this (would) force me to be more regular (in terms of) interacting with others (on the forum)."(P4)*

When asked whether it would matter that among the participants on the forum, there was also an expert or therapist, some participants responded that they would have felt more motivated to post knowing that someone with authority and required expertise would be responding to them. But other participants were more hesitant about the presence of experts. Other participants were quite unsure though, whether they would be more inclined to comment or less based on whether the other participants knew their identity in real-life and there were privacy concerns with respect to people being able to determine their real identities due to their nicknames having a close match with their real name.

> *"I am not sure, at the same time, if you have a friend, you would confide in them more but if you have something on your mind and you don't want to be judged, then someone who doesn't know you, a complete stranger would be better." (P7)*

Participants were more motivated to use the Popular Tools feature to quickly explore then most used tools and components in the application especially at the beginning on the intervention as said by a participant:

> *"...and the popular tools, I find it very very [sic] useful because for instance for someone who doesn't know where to start hmm[sic] at the beginning...I can explore the popular tools to see what other people do in general so that I know where to start."(P5)*

In line with the above, past the beginning phase, the popular tools feature was credited to serve the curiosity of participants who then used the feature to find out which tools their peers have been using most in the application compared to their own usage and would then go on to try

these tools as well. The popular tools feature also served as a reassurance to participants who were eager to know whether they have been using the same set of tools as others. Several participants voiced out that they did not find the *Popular Tools* useful enough mainly due to the limited number of tools that it was tracking (N=9) as they preferred to check each of the tools individually. However, they did indicate that it would be more suitable in cases where there were many more tools being tracked as quoted below:

> *"There were not many tools, so I just went through the list (instead of using the popular tools feature)." (P11)*

> *"If there were more than five six things, then the popular tools (would be) really useful" (P16)*

However, the popular tools feature was found to be useful by participants as a quick way or as a short-cut to reach the most common used tools in the intervention as in addition to providing a leader board based on usage, each item in the list also had a button which when clicked, opened that specific tool as mentioned by a participant:

> *"The popular tools one was good I found, (it) gave me a faster access to the (other) tools."(P7)*

Concerns and Suggested Improvements

The participants were prompted to talk about issues that they encountered when using the application along with its social media features and were also encouraged to suggest improvements that would facilitate their use of the application.

While many participants credited the application's simplicity and minimalist aspect that avoided information overload as quoted in the two previous themes, several other participants pointed out that would have desired a more aesthetically-pleasing application. In addition to text-based information, the use of graphics, audio and video were suggested as quoted below:

> *"The aesthetics or attractiveness was lacking. At the moment, the app is a bit bland, very bland. To me it's a bit too descriptive like it's too wordy. (I) would like more audio and video." P11*

When queried about their engagement with the forum, several participants pointed out the overall low-level activity by other members leading to their own reduced participation but at the same time several participants explicitly explained that they were by nature, passive users of forums who are more used to reading posts rather than actively posting:

> *"I think it was a good facility to have but I think it depends on the other participants that are gonna[sic] be active using the forum. I thought that in the group that we were in, not many people used the forum. It was not as helpful as it could have been." (P18)*

> *"If there were more posts, more people. Cause [sic] I remember I read a comment and then I came back 1 day later and it was the same (without any reply)."(P15)*

> *"I didn't post anything else because I am a little shy to talk to others. That's why I like the forum because I can read what others are writing."(P13)*

One of the most suggested elements with respect to the forum was a form of notification when new posts or replies to existing posts were being published. With one participant explaining that with the current version of the application, one must manually search for a particular post to see whether there have been replies. While notifications with a direct link to specific comments could help, a search functionality for the forum could also be considered as was suggested by the participants:

> *"like get a notice [sic], ohh someone had posted and I like get around to see what was written and then I would write my own comment." (P11)*

> *" ...otherwise I need to go find my post"(P5), when I post(ed) it or where, I need to search it. And I don't think there is a search (functionality), so I have to do it manually." (P5)*

Another suggestion that according to a participant might boost engagement with the application and its social media features would be the gamification of its usage by allocating rewards for undertaking tasks such as posting a comment on the forum or trying a particular tool as quoted below:

> *"Oh maybe some rewards, not money; I remember Duolingo, like getting points. I thought maybe if you want more interactions."(P20)*

The assignment of a personal therapist, expert or adviser to each participant within the application who could then communicate privately mode was also a desired feature which would complement the advice that participants received from peers through the forum. One of the participants was quoted saying:

> *"Maybe If I had a special adviser where [sic] I can share my things on a one-to-one basis.") (P13)*

The inclusion of a profile picture or additional profile information for each participant was suggested so as to facilitate bonding among participants and encourage a sense of trust among them. Some participants indicated that having such information would also help them find common interests among themselves.

> *"It would be nice if every person (participating) had like a profile, then put (a) picture, their names and you see their age. You could have something in common with that person…"(P9)*

However, a few participants were not so eager to have a profile picture although they were agreeable to sharing other kind of data such as age and location:

> *"I would not necessarily put pictures, but I wouldn't mind having a profile."(P18)*

> *"I think having a profile picture could be helpful to know other people but if I had my own picture, I would be stressed to post because people might know me." (P15)*

With another participant suggesting that only the experts or therapists should have profiles containing information that can be used by participants to reinforce their trust in their authority and support provided:

> *"If the profile for the expert was available in the forum, I would Google it, and see more about him or her. Maybe not for all people share their information, maybe for the experts only. It increase my trust."(P3)*

At least one participant however, favoured complete anonymity and had concerns than posting about one's issues might affect the image of that person in case other people can identify that participant in real-life.

7.4.2.1 Summary of Key Findings

The application along with both of the SMFs included were reported by the participants as being "easy to use", that is, they were able to launch the application, understand the different functionalities available and successfully interact with them without the need for any additional

training or user manuals. It was interesting to note that one of the SMFs, the forum, was used by a few participants to seek clarifications or to clear doubts with peers about using the application itself.

Active participation in the forum was relatively low mainly due to the rather short duration of the experiment. It was suggested that having more 'leading' comments posted would further encourage participants to post as well. Similarly, the presence of experts or therapists could have also motivated their involvement according to the participants. Some of them indicated that they were by nature more passive and preferred to only read what others were posting.

An interesting finding about the two SMFs included was their capability to enable participants to mutually-reassure one another about their usage of the application or even their progress simply by knowing what the other participants were doing.

In-line with the pilot study (See Chapter 5.), participants described how the simplicity of the application along with the included SMFs and their functionalities motivated them to remain engaged with it. The reduced amount of text for describing the different elements and the careful use of simple English words as labels have also been welcomed positively by the participants. Some suggestions by participants to further improve the application and the SMFs were the use of more graphics, audio and video components along with notifications and one-to-one messaging functionalities.

7.5 Results (Authoring Tool)

The authoring tool, specially the parts for including and customising SMFs were evaluated among experienced intervention designers who had participated in the focus group studies and they were requested to complete a SUS questionnaire after completing the set of tasks involving the inclusion of a forum and a popular tools feature in a behavioural intervention. The average SUS score was 75.25 which is considered as above average in terms of usability. They were also requested to rate the complexity levels of the tool for accomplishing three tasks in the range of 1 to 10 and the results are shown in the table below:

Task / Participant	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**Mean**
Specifying items that required tracking.	9	8	8	9	10	8	10	8	7	9	8.6
Creating and customising the forum.	9	8	8	9	10	8	9	6	8	6	8.1

Creating and customising the statistical feature.	9	9	8	9	9	8	9	5	10	5	8.1

Table 20. Authoring Tool's Task Complexity Ratings

7.6 Chapter Conclusion

Most participants in this study found the social media components (forum and popular tools) to be easy to use and did not require training or any additional help to be able to use them properly as found in the SUS scores and through the interviews.

While many participants liked the forum, there were concerns with respect to the lack of activity or relevant information that matched the interests of some of them. This was mainly due to the relatively low number of participants given access to the forum during a given period (maximum of 15) and the short period of that access (1 week).

None of the participants knew one another before this experiment; This was expected due to the nature of recruitment and it reproduced some of the conditions that usually prevail in live behavioural interventions. While several participants pointed out this aspect of unfamiliarity with their peers as hindering their engagement with the forum, others mentioned that having real-life friends also participating in the intervention could potentially make them uncomfortable to share things on the forum. Therefore, finding the proper balance in these cases is important; it could be dependent on the nature of a particular intervention and the nature of discussions expected to be carried out through the forum. Related to familiarity among participants is the issue of their anonymity. The participants were in most cases interested to learn more about their peers but they were not so eager to share their own information to others for fear of being identified in real life. The degree of anonymity level expected varied among the participants from completely public to completely anonymous with no personal data shared. Again, the nature of the interventions would play an important role in deciding the minimum amount of personal data being shared among participants but also, properly informing participants about who will be having access to what data and its importance could significantly reassure them.

In many behavioural interventions, therapists/moderators/experts usually have a role such as monitoring discussions on forums or even participating in these discussions. However, for our experiment, no therapist was present. Several participants expressed desires to have such people to provide them with more trustworthy or authoritative support with a minority feeling concerned and preferring only peers at the same levels as themselves. This issue could possibly be addressed through proper counselling of this category of participants before they embark on an intervention.

The popular tools component which combined aggregated data with a ranking table for items in the intervention had more mixed appreciations from participants. It was found to be most suitable at the beginning of the intervention when it was used to explore the application's other tools. It was suggested by some participants that since there were less than ten tools in the application, once they had tried them all, they already had their preferences and did not feel the need to know what other participants were using the most. Therefore, it would be more useful in cases where there were many more tools in an application.

The main objective of this study was to validate our claim that social media components included and customised through a generic framework without the requirement for computer programming skills can be highly usable and can have the potential to benefit end-users. Based on our analysis of the inclusion of two social media features in a behavioural intervention, we can confirm that this is the case.

The results for the Authoring Tool's evaluation was also promising with above average SUS scores, implying that it had a good usability. Similarly, with mean values of more than 8 in the range 1-10, for carrying out different tasks for including SMFs and customising them in an intervention, it can be considered that the builders (participants) can easily use the tool.

The SMFs were included using the intervention authoring tool which was also evaluated with the help of intervention builders who participated in the focus group study (See Chapter 3.). This chapter demonstrated that SMFs can be easily incorporated in DBCIs using the intervention authoring tool. Analysis of the results indicates that the SMFs that were included were perceived to be user-friendly and helpful by the majority of participants. This addresses the research question "*Do end-users perceive SMFs as useful and user-friendly components within interventions built by non-computer programming savvy intervention builders?"*. The intervention authoring tool was very welcomed by intervention builders who found it to be intuitive and easy to use. A solution for the research question "*How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?"* would therefore be the web-based graphical interface referred to as an intervention authoring tool which provides builders with sufficient flexibility to customise and include SMFs in DBCIs.

Chapter 8. Conclusion and Future Work

This thesis has considered the inclusion of Social Media Features in behavioural interventions and its implications. This final chapter summarises the research work and its conclusions along with its key contributions. Key areas for future research are also proposed and which could extend this work.

8.1 Thesis Summary

Based on our preliminary literature review, we found very few systematic reviews which addressed SMFs in behavioural interventions and they mostly focused on one or two behaviours only or a restricted set of SMFs. This was a strong justification for undertaking a systematic review of SMFs in behavioural interventions which addressed a range of behaviours and comprised of a wide set of SMFs (See Chapter 2.). This systematic review enabled us to identify their prevalence in interventions, addressing a range of behaviours but also revealed the strong possibility that in many cases these SMFs had been included without much empirical evidence of their positive implications with regards to the behaviours targeted. Another issue uncovered was that all these interventions either used public OSNs or hard-coded one-off SMFs by professional developers versed in computer programming. Similarly, there was a lack of standards in reporting on their description and impact in the studies that were reviewed, making comparisons across studies and interventions difficult. In order to address these issues, we have developed a taxonomy of SMFs for behavioural interventions (See Chapter 4.) which intervention builders can use as a guide and which will facilitate cross-study comparisons. This taxonomy was developed in parallel with the systematic review and also considered the views of experienced intervention builders gathered through a focus group study as reported in Chapter 3. Chapter 5-7. reported on the development of a generic framework for building behavioural interventions and enable intervention builders to include SMFs into these interventions without the need for computer programming skills and we demonstrated that this method was efficient in adding and customising SMFs that regular users could easily use and found helpful.

8.2 Limitations

Due to the highly complex nature of DBCIs, this thesis has limited its scope to only interventions that addressed modifiable risk factors published by the World Health Organisation (WHO) [44]. Therefore, the systematic literature review undertaken included only studies that fit this criterion. Furthermore, it was found that not all of the studies published sufficient data and information about the various SMFs included in their interventions.

Therefore, our attempt to corelate SMFs with the interventions' overall outcome should be further researched.

The participants of our focus group study were all experienced researchers and intervention builders from the University of Southampton, UK who are leading experts in this area. For practical reasons, it was not possible to include participants from other parts of the UK or the world.

While it was initially planned to have users of existing interventions participate in our experiments, due to confidentiality and ethical issues, it has not been possible to obtain their contact details. The participants enrolled were University of Southampton students and staff members, all aged above eighteen years old. Therefore, the results reported are based on that specific group and should be extrapolated to other communities of users with due care.

8.3 Contributions

This work helps in advancing knowledge on the use of social media features in digital behaviour change interventions. It has been found that these features were being included in interventions under multiple appellations and that there was no standard way for referring to them within publications. Similarly, there is a lack of data with regards to their impact on the outcome of interventions.

Intervention builders, while keen to incorporate SMFs within their interventions, found it complex and beyond their technical abilities to do so. This was mainly due to the fact that they are usually from social science backgrounds and have limited computer programming skills.

Through a proper understanding of the various issues involved, the various outputs from the research work undertaken and that would be beneficial to the research community as well as intervention builders are outlined below:

Chapter 1.

In the first chapter, based on published and peer-reviewed literature, this thesis exposed the under-usage of SMFs and exploitation of their full potential within DBCIs. This was mainly due to the lack of a generic framework to guide intervention designers. In this respect, the formulation of five key research questions was done to help determine whether SMFs, incorporated through a generic framework could help address these issues.

Chapter 2.

A systematic literature review (SLR) on the inclusion of SMFs in DBCIs was undertaken and which was the first such review specifically addressing this specialised area to be published [133]. The publication included a taxonomy of SMFs and a set of recommendations about how to maximise their benefits.

Chapter 3.

A focus group study and its subsequent thematic analysis provided a better understanding of researchers and behavioural intervention builders with respect to their expectations about the inclusion of SMFs in DBCIs. While the current research used the findings to propose a generic framework, the analysis will also be useful for future research in the area.

Chapter 4.

A taxonomy of social media features which are used in DBCIs has been developed and presented. It is expected that the taxonomy will create awareness among researchers and intervention builders about the different SMFs and also encourage them to use standardised terminologies when referring to these features. This will in turn facilitate future cross-study evaluations.

Chapter 5.

The use of findings from a focus group study to help in the design and running of a pilot experiment was demonstrated in Chapter 5. The experiment was subsequently evaluated through expert review and which enabled an enhanced understanding of intervention builders' expectations. This methodology can be adopted in other future research.

Furthermore, the System Usability Scale (SUS) questionnaire [128, 129] which is widely used to assess a wide range of interfaces was modified to better suit the assessment of social media features. This adaptation can be employed in similar or related evaluations.

Chapter 6. & 7.

A generic framework known as LifeGuide Toolbox was extended to enable intervention builders to easily incorporate SMFs in DBCIs. A novel method for including and customising SMFs was developed and implemented in a web-based intervention authoring tool. The extended framework can be used to create cross-platform mobile-based applications for DBCIs without requiring builders to have computer programming skills. This has been evaluated through a two-week study which demonstrated that users found interventions with SMFs

developed through our generic framework to be intuitive and supportive of their expectations from the application.

8.4 Future Work

Our systematic review will benefit from periodic updating as more peer-reviewed publications matching our criteria are made available. Furthermore, this can be further expanded to include additional behaviours to the current set of behaviours considered for the review in this thesis. The taxonomy of SMF can be further refined with the addition of new SMFs as they emerge and updating of existing ones as technologies are expected to evolve. As proposed in our work, this taxonomy can complement and possibly merge as an extension to an existing taxonomy for standardising behavioural interventions. Also, more research to find ways for isolating the effects of social media features on intervention users is highly desirable as this review has found that many studies do not report on these aspects clearly as they are rarely the primary component of an intervention being tested.

As mentioned in the limitations section, a relatively small sample was used for the experiment and they were from a closed network. Running the experiment with a larger number of participants from different communities and over a longer period of time would be help validate the findings of this research work.

A prioritised list of SMFs should be drawn up based on the systematic review to include them in the intervention Authoring Tool so that they can be included in future behavioural interventions. While this research did not focus specifically on the impact of SMFs in behavioural interventions, it was clear from our findings that not all SMFs are suitable in all contexts and for all addressed behaviours. Therefore, it would be highly desirable that intervention builders use the generic framework to build a number of interventions targeting a range of behaviours and testing the impact of different SMFs in them.

8.5 Closing Statements

In Chapter 1., a number of key research questions were identified that this research work has helped us address. At this stage, we can proceed to match our findings to these questions.

1 Do behavioural interventions that integrate SMFs have positive effects on end-users?

Based on the finding of our systematic literature review (See Chapter 2.), we can confidently confirm that the majority of behavioural interventions which included SMFs and who reported on their impact, found that they were largely perceived as being beneficial by end-users. Similarly, other studies which also included these features but only reported on the overall interventions' outcomes, published positive results.

2 *What are the expectations of intervention builders with respect to the inclusion of SMFs in behavioural interventions?*

Based on our focus group study which involved experienced intervention builders, it was found that they very much welcomed the possibility of including SMFs in their interventions. However, their main concern was the lack of empirical evidence with regards to the impact of SMFs in different contexts. Another issue was with regards to the level of control that they would desire to be in place alongside these SMFs. However, all the intervention builders who participated in the focus groups agreed that the different SMFs could all potentially be beneficial within behavioural interventions but would need to be tested first. In turn, having the ability to include and customise SMFs with the possibility of controls such as moderation were highly desired.

3 *How can SMFs be organised so as to standardise, facilitate and guide their inclusion in behavioural interventions?*

A taxonomy of SMFs for behavioural interventions has been developed and presented in Chapter 4. to address these issues. Intervention builders can use this taxonomy to refer to and describe SMFs that they chose to include in their behavioural interventions resulting in better standardisation which will facilitate cross-study comparisons.

4 *How can SMFs be designed in order to alleviate the complex computer programming technicalities for intervention builders to integrate them within their interventions?*

Based on our method and tool developed which was presented in Chapter 6., SMFs can be easily included when building interventions through a web-based graphical interface referred to as an intervention authoring tool which provides builders with sufficient flexibility to customise the features.

5 *Do end-users perceive SMFs as useful and user-friendly components within interventions built by non-computer programming savvy intervention builders?*

During the final study presented in Chapter 7. we ran an intervention for two weeks. The intervention was built using an extended version of the LifeGuide Toolbox system. Data was gathered in through multiple methods, namely, automated logging, post-study questionnaire and end-user interviews. Analysis of the results indicate that the SMFs that were included were perceived to be user-friendly and helpful by the majority of participants.

The findings in relation to the key research questions strongly support the hypothesis that "*Social Media Features customised by intervention builders without computer programming skills can score high in terms of usability and can provide a number of benefits to end-users when integrated in behavioural interventions through a generic framework.".*

Appendices

Appendix A. Social Media Features Identified in the Studies Included in our Systematic Review

		SMFs / Paper(s)	4	6	7	11	14, 139	34	38	44	45	46	47	48	49	50, 51	52	53	55, 56	57	58	59	60	61	62	63	64
	Identity Representation	User Profile	X		X		X		X	X	X	X	X		X		X										
		Avatar																									
Communication	Synchronous	Chatroom (Text-based)				X					X					X							X	X	X	X	
		Group Video Conferencing																			X	X	X				
	Asynchronous	Online Forum		X	X	X		X	X	X	X	X	X			X		X	X	X		X	X	X	X	X	X
		Mailing List																									
		Peer Commenting	X		X		X		X	X	X	X	X	X	X		X										
		Social Noticeboard (Group Walls)			X		X								X		X										
	One-to-One	Text Chatting					X								X		X										
		Peer SMS															X										
		Peer Web Messaging / Emailing	X				X			X	X	X	X		X		X						X	X	X		
		Video Call																									
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)	X				X			X	X	X	X		X		X										
		Social Tagging																									
		Peer Data Rating / Evaluation																									
	Peer Grouping	OSN-Based Groups			X		X								X		X										
		Online Teams / Clubs / Groups	X																								
		One-to-One Social Connections (Friending/Buddy)	X		X		X		X	X	X	X	X	X	X		X										X
	Data Sharing	Activity Data	X											X													
		Goal Data								X	X	X	X	X													
		Poll Voting							X								X		X								
		Blogs/ Testimonial/Experience Sharing							X	X	X	X	X									X					
	Competitive	Social Quiz																									
		Social Rewards	X	X																							
		Social Challenge	X		X																						
		Activities & Contests (Team-Based)																									
		Activities & Contests (Individual-Based)																									
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table	X																								
		Other Textual Comparison												X													
		Graphical / Video-based Comparison																									
		Social Norm / Aggregated Data Comparison												X													
	Peer Data Updates	Social Notification																									
		Feeds	X		X		X		X	X	X	X	X	X	X		X										
	Online Social Networks	Generic & Conventional OSN					X								X		X										
		Virtual World OSN	X		X				X	X	X	X	X														X
		Purpose Designed OSN																									

		SMFs / Paper(s)	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
	Identity Representation	User Profile					X			X	X		X			X											
		Avatar			X																						
Communication	Synchronous	Chatroom (Text-based)											X					X					X				
		Group Video Conferencing																									
	Asynchronous	Online Forum				X			X		X	X	X	X	X	X	X	X	X	X	X	X					
		Mailing List											X										X				
		Peer Commenting					X			X														X			
		Social Noticeboard (Group Walls)					X			X						X											
	One-to-One	Text Chatting					X			X																	
		Peer SMS																							X	X	X
		Peer Web Messaging / Emailing					X			X			X														
		Video Call																									
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)					X			X														X			
		Social Tagging																									
		Peer Data Rating / Evaluation																						X			
	Peer Grouping	OSN-Based Groups					X									X											
		Online Teams / Clubs / Groups	X																								X
		One-to-One Social Connections (Friending/Buddy)	X	X	X		X			X														X	X	X	
	Data Sharing	Activity Data		X																					X		X
		Goal Data																									
		Poll Voting					X			X																	
		Blogs/ Testimonial/Experience Sharing										X							X								
	Competitive	Social Quiz																									
		Social Rewards	X					X					X														
		Social Challenge	X													X											
		Activities & Contests (Team-Based)																									
		Activities & Contests (Individual-Based)			X			X					X						X								
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table						X																			
		Other Textual Comparison																									X
		Graphical / Video-based Comparison	X		X																						
		Social Norm / Aggregated Data Comparison															X							X			
	Peer Data Updates	Social Notification			X																						
		Feeds					X			X																	
	Online Social Networks	Generic & Conventional OSN					X			X																	
		Virtual World OSN												X		X											
		Purpose Designed OSN																									

		SMFs / Paper(s)	90	91	92	93	94	95	96	97	98	99	100, 101	102	103	104	105	106	107	108	109	110	111	112, 113, 114	115	116	118
	Identity Representation	User Profile	X	X		X				X	X			X	X	X			X			X			X	X	X
		Avatar						X			X			X	X						X					X	
Communication	Synchronous	Chatroom (Text-based)									X		X	X	X											X	
		Group Video Conferencing																									
	Asynchronous	Online Forum		X								X	X								X						X
		Mailing List																									
		Peer Commenting	X			X		X		X									X	X		X	X				X
		Social Noticeboard (Group Walls)				X				X								X	X								X
	One-to-One	Text Chatting	X		X	X				X	X			X					X			X					
		Peer SMS																									
		Peer Web Messaging / Emailing	X			X				X				X		X			X			X	X				
		Video Call					X																				
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)	X			X		X		X									X			X					
		Social Tagging																									
		Peer Data Rating / Evaluation																									
	Peer Grouping	OSN-Based Groups				X				X								X	X						X		
		Online Teams / Clubs / Groups		X	X												X				X						
		One-to-One Social Connections (Friending/Buddy)	X	X		X	X			X	X			X	X	X		X	X			X	X	X	X	X	X
	Data Sharing	Activity Data		X		X	X							X		X	X	X		X		X	X		X		
		Goal Data																									
		Poll Voting																									
		Blogs/ Testimonial/Experience Sharing						X	X																		X
	Competitive	Social Quiz																									X
		Social Rewards				X				X							X						X				
		Social Challenge		X																							
		Activities & Contests (Team-Based)			X																						
		Activities & Contests (Individual-Based)														X	X	X				X	X				
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table			X											X						X	X				
		Other Textual Comparison		X		X										X				X					X		
		Graphical / Video-based Comparison					X							X			X				X						
		Social Norm / Aggregated Data Comparison																			X						
	Peer Data Updates	Social Notification							X													X					
		Feeds	X	X		X				X									X			X		X			X
	Online Social Networks	Generic & Conventional OSN	X			X				X									X			X		X			
		Virtual World OSN														X		X					X		X		X
		Purpose Designed OSN									X			X	X											X	

		SMFs / Paper(s)	122	125	131	132	133	134	135	136, 137	138	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
Communication	Identity Representation	User Profile		X			X																				
		Avatar					X																	X			
	Synchronous	Chatroom (Text-based)												X			X		X				X				
		Group Video Conferencing																									
	Asynchronous	Online Forum	X		X	X		X	X	X	X		X	X	X	X		X	X		X		X			X	X
		Mailing List												X													
		Peer Commenting		X													X								X		
		Social Noticeboard (Group Walls)		X												X											
	One-to-One	Text Chatting		X															X								
		Peer SMS																		X							
		Peer Web Messaging / Emailing		X										X					X					X			
		Video Call																									
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)		X																							
		Social Tagging																						X			
		Peer Data Rating / Evaluation																									
	Peer Grouping	OSN-Based Groups		X																							
		Online Teams / Clubs / Groups																									
		One-to-One Social Connections (Friending/Buddy)		X			X																				
	Data Sharing	Activity Data					X																	X			
		Goal Data																									
		Poll Voting																									
		Blogs/ Testimonial/Experience Sharing										X					X								X		
	Competitive	Social Quiz														X											
		Social Rewards																						X			
		Social Challenge																									
		Activities & Contests (Team-Based)																				X					
		Activities & Contests (Individual-Based)					X															X					
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table					X																				
		Other Textual Comparison																						X			
		Graphical / Video-based Comparison																				X					
		Social Norm / Aggregated Data Comparison										X				X						X					
	Peer Data Updates	Social Notification																									
		Feeds		X																							
	Online Social Networks	Generic & Conventional OSN		X																							
		Virtual World OSN					X																				
		Purpose Designed OSN																									

		SMFs / Paper(s)	156	157	158	159	160	161	162	163	164	165	166	167, 168	169	170	171	172	173	174	175	176	177	178	179	180	181
	Identity Representation	User Profile				X				X			X														
		Avatar																									
Communication	Synchronous	Chatroom (Text-based)	X																								
		Group Video Conferencing																									
	Asynchronous	Online Forum	X	X	X			X	X	X		X		X	X	X	X			X		X	X	X	X	X	X
		Mailing List							X									X									
		Peer Commenting				X				X			X									X					
		Social Noticeboard (Group Walls)				X							X	X													
	One-to-One	Text Chatting				X				X			X														
		Peer SMS																	X		X						
		Peer Web Messaging / Emailing				X		X		X			X											X			X
		Video Call																									
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)				X				X			X														
		Social Tagging					X															X					
		Peer Data Rating / Evaluation																									
	Peer Grouping	OSN-Based Groups				X																					
		Online Teams / Clubs / Groups								X																	
		One-to-One Social Connections (Friending/Buddy)				X		X		X	X		X						X		X			X			X
	Data Sharing	Activity Data				X											X		X								
		Goal Data																			X						
		Poll Voting											X								X						
		Blogs/ Testimonial/Experience Sharing											X														
	Competitive	Social Quiz																			X						
		Social Rewards								X																	
		Social Challenge																									
		Activities & Contests (Team-Based)																									
		Activities & Contests (Individual-Based)								X																	
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table								X																	
		Other Textual Comparison									X						X										
		Graphical / Video-based Comparison																									
		Social Norm / Aggregated Data Comparison																									
	Peer Data Updates	Social Notification																									
		Feeds				X				X			X														
	Online Social Networks	Generic & Conventional OSN				X				X			X														
		Virtual World OSN																									
		Purpose Designed OSN																									

		SMFs / Paper(s)	182	183	184	185	186	187	188	189	190
	Identity Representation	User Profile	X				X				
		Avatar									
Communication	Synchronous	Chatroom (Text-based)						X		X	
		Group Video Conferencing									
	Asynchronous	Online Forum		X	X	X	X			X	
		Mailing List									
		Peer Commenting	X				X		X		
		Social Noticeboard (Group Walls)	X								
	One-to-One	Text Chatting	X								
		Peer SMS									
		Peer Web Messaging / Emailing								X	
		Video Call									
	One-Way	Symbolic Support (Likes, Thumb-ups, etc)	X								
		Social Tagging									
		Peer Data Rating / Evaluation									
	Peer Grouping	OSN-Based Groups	X								
		Online Teams / Clubs / Groups									X
		One-to-One Social Connections (Friending/Buddy)	X							X	
	Data Sharing	Activity Data									
		Goal Data									
		Poll Voting	X								
		Blogs/ Testimonial/Experience Sharing							X		
	Competitive	Social Quiz									
		Social Rewards									
		Social Challenge									
		Activities & Contests (Team-Based)									X
		Activities & Contests (Individual-Based)									
Activity Data Viewing	Peer Data Comparison	Leaderboard / Ranking Table									
		Other Textual Comparison									
		Graphical / Video-based Comparison									
		Social Norm / Aggregated Data Comparison									X
	Peer Data Updates	Social Notification									
		Feeds	X								
	Online Social Networks	Generic & Conventional OSN	X								
		Virtual World OSN							X		
		Purpose Designed OSN									

Appendix B Initial Analysis Coding Scheme for Focus Group Study

Codes	Code Labels	SubCodes	Subcode Labels
A1	Perception of researchers towards the use of OSN and SNF in Digital Interventions		
A2	Social Networking Feature		
		A2X1	User Profiles
			A2X1#1: Avatar
			A2X1#2: Filled with Baseline Data
		A2X2	Groups
		A2X3	Buddy/Rival Nomination
		A2X4	Notifications & Reminders
		A2X5	Feeds
		A2X6	Knowledge Repository
		A2X7	Self-reporting measures
		A2X8	Diaries
		A2X9	Progress viewing
		A2X10	Leader Boads / Ranking Tables
		A2X11	Challenges and Goal Setting
		A2X12	Questionnaires, polls and question asking
			A2X12#1: Polls
A3	Public Social Network		A2X12#2: Question Asking
A4	Private Social Network		
A5	Example of Application using SNF		
A6	Behaviour/Condition Targetted by Digital Intervention		
A7	Actions of digital intervention participants using SNF		
A8	Concerns about SNF from Researchers' Perspective		
A9	Advantages of Digital Interventions		
A10	Limitations of of Digital Interventions		
A11	Property of Online Social Networks		
A12	Concerns about SNF from Digital Intervention Participants' Perspective		
A13	Social Support		
A14	Ubhave		

Figure 47. Coding Scheme Used in Initial Thematic Analysis

Appendix C: Task List for Evaluation

UNIVERSITY OF Southampton

Title of study: Evaluation of Social Networking Feature Prototype

Investigator name: Sheik Mohammad Roushdat Ally Elaheebocus
ERGO Study ID number: 14262

Task Sheet

Please read the following instructions:
A list of tasks has been provided below. You should undertake them by using the mobile application which can be accessed through the green and black coloured icon, labelled, 'Lifeguide Tool'. The icon is shown below:

It is preferable to undertake each task using the order provided. There is no defined time-limit. While carrying out the tasks, you are encouraged to think aloud.
As soon as you complete a task, write 'Y' in its corresponding box and move to the next task. In case you are not able to complete a task, briefly think aloud about the reasons, write 'No' in its corresponding box and move to the next task.

TASKS	Y/N
1. Locate and Open the Popular Tools feature.	
2. View popular tools; the popularity of which are determined by your own interaction with the application.	
3. View popular tools; the popularity of which are determined by all participants' interaction with the application.	
4. Locate and launch the most popular tool based on all the intervention participants' ratings.	
5. Locate and Launch the tool that you have used the least so far according to the listings.	

Appendix D: Evaluation Questionnaire (Section A & B)

UNIVERSITY OF Southampton

Title of study: Evaluation of Social Networking Feature Prototype

Investigator name: Sheik Mohammad Roushdat Ally Elaheebocus
ERGO Study ID number: 14262

Evaluation Questionnaire

Section A:
Please fill in the ratings based on whether you strongly agree or disagree with each statement in relation to the 'Popular Tools' feature that you have used in the mobile application.

	The statements below all refer to the 'Popular Tools' feature that you have used in the mobile application.	Strongly Disagree				Strongly Agree
		1	2	3	4	5
1	I think that I would like to use the 'Popular Tools' feature frequently.					
2	I found the feature unnecessarily complex.					
3	I thought the feature was easy to use.					
4	I think that I would need the support of a technical person to be able to use this feature.					
5	I found the various functions in this feature were well integrated.					
6	I thought there was too much inconsistency in this feature.					
7	I would imagine that most people would learn to use this feature very quickly.					
8	I found the feature very cumbersome (awkward) to use.					
9	I felt very confident using the feature.					
10	I needed to learn a lot of things before I could get going with this feature.					

Section B:
The section consists of 'Yes /No' styled questions along with a few open-ended ones. Please answer them. In case you run out of space, feel free to write on the blank sheets made available to you while labelling your answers with the corresponding question number.

1. Briefly describe the main functionalities of the 'Popular Tools' feature.

   ---

2. When using the feature, did the positioning of the button to access the 'Popular Tools' section matter and why?

   Yes / No *(please encircle your chosen answer)*

   (i) Why?

   ---

3. Was it beneficial to get data aggregated from

   (i) all the intervention participants? Yes / No *(please encircle your chosen answer)*

   (ii) only your own interaction with the application? Yes / No *(please encircle your chosen answer)*

4. If you were given the choice of whether to share your anonymised data to be used for aggregating usage and ratings of tools which would then be made available to other participants, would you have agreed to this?

   Yes / No *(please encircle your chosen answer)*

   (i) If you answered Yes to the above, skip and move to question 5.

   Suppose you were to be given access to the aggregated data of other participants only if you agreed to share yours. Would this have changed your decision?

   Yes / No *(please encircle your chosen answer)*

5. According to you, how could the 'Popular Tools' feature be improved?

---

6. Describe whether the availability of the ‘Popular Tools’ feature impacts on your use of the mobile application in general?

---

7. Can you think of any other features similar to the 'Popular Tools' in the way that data from all participants are used in other mobile applications?

---

8. Are you engaged in any form of online social networks (e.g. Facebook, Twitter etc?)

   Yes / No *(please encircle your chosen answer)*

   (i) If you answered Yes to the above, list the networks and main activities that you engage in. If you answered No, briefly provide your motivation if any.

Appendix E: Semi-Structured Interview Questions

1. What are your thoughts about the 'Popular Tools' feature?
    (i) What impact do you think the popular tools feature might have on an intervention?

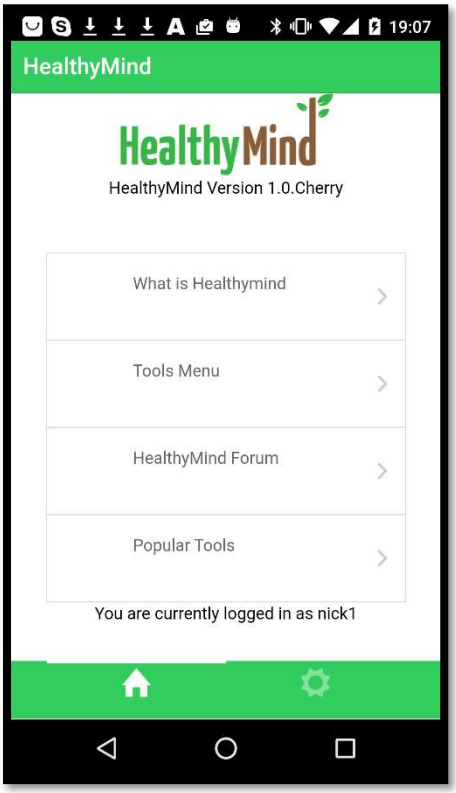
2. How do you think the 'Popular Tools' feature will fit with the interventions you're currently working on?
    (i) Any aspect that you did not like about the feature?
    (ii) Do you have any specific requirement/changes/adaptations that you think will be required?

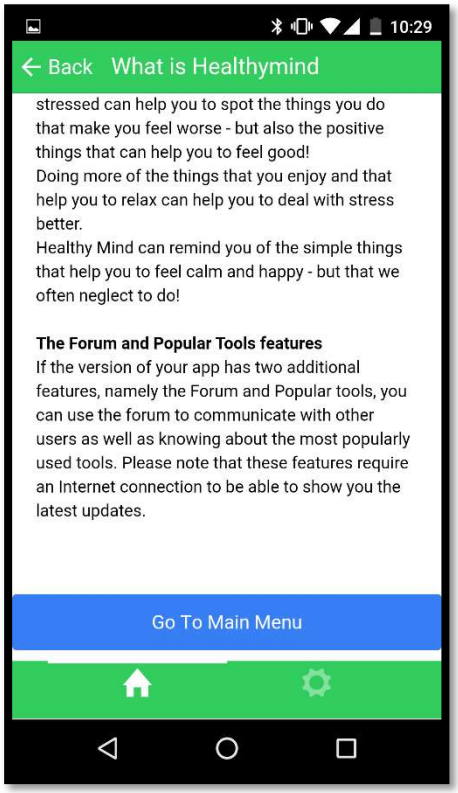
3. Talk me through your thoughts about the more conventional poll feature where the Intervention contains a poll for participants to vote and see results of all other participants?

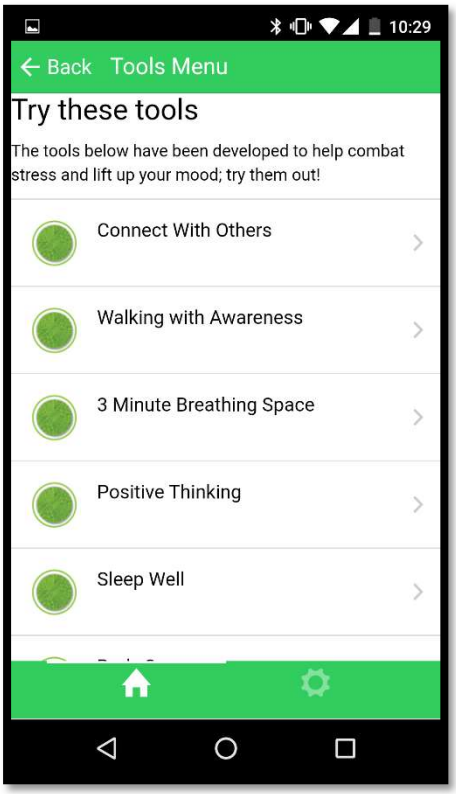
4. The next Social Networking Feature for integration in DBCIs that came out as popular during focus group studies was a socially-enhanced knowledge repository where the intervention offer a set of material (question-answer style or topic based) and information about most popular resources are provided to participants. What are your thoughts about this?

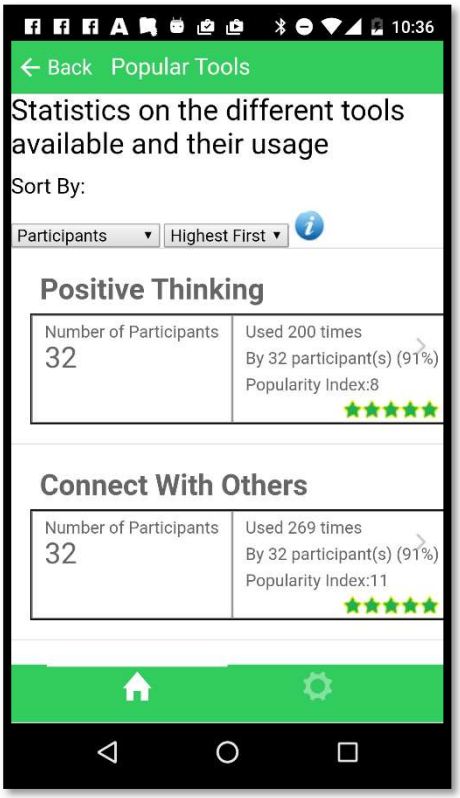
    (i) Thinking about the interventions you're currently working on, how useful you think this will be?

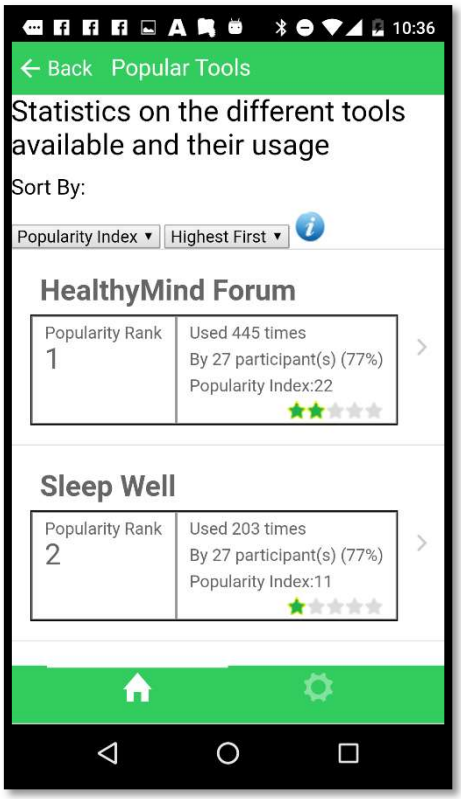
Appendix F : Screenshots of Mobile Application Developed and Used for Study

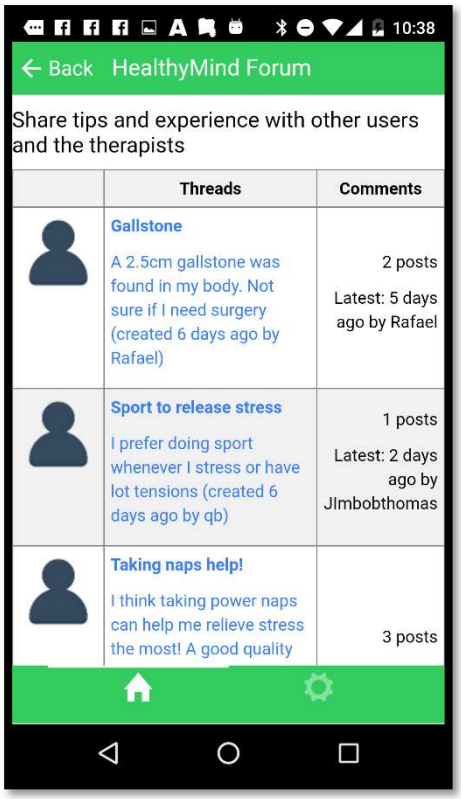


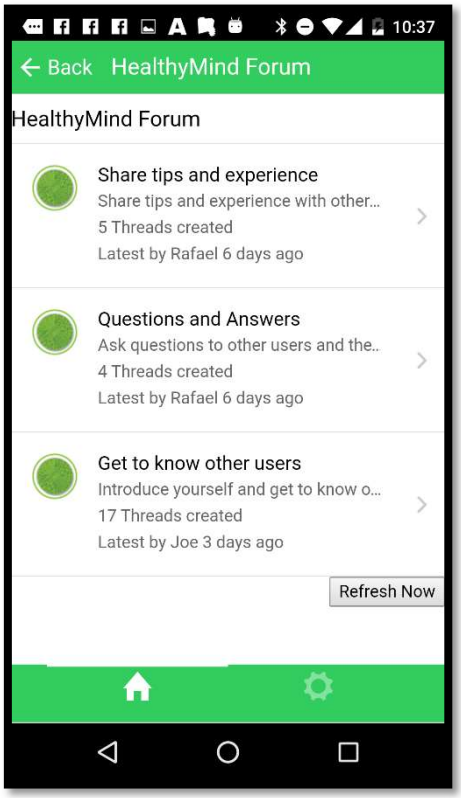


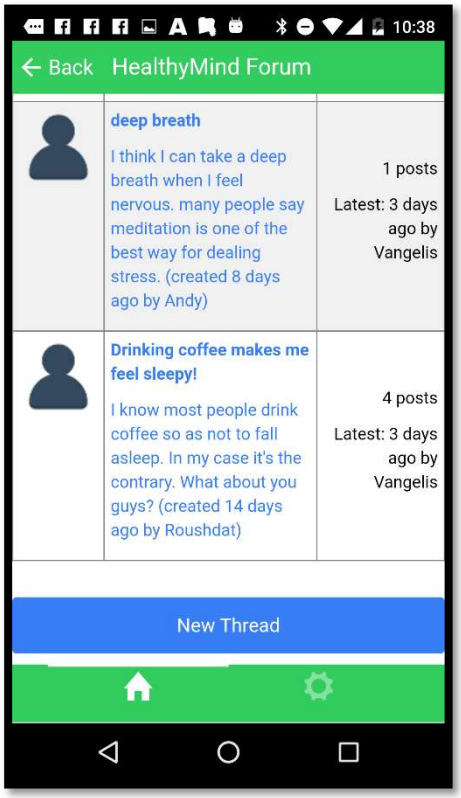





10:36
Back Popular Tools
Statistics on the different tools available and their usage
Sort By:
Popularity Index
Highest First
HealthyMind Forum
Popularity Rank 1
Used 445 times
By 27 participant(s) (77%)
Popularity Index:22
Sleep Well
Popularity Rank 2
Used 203 times
By 27 participant(s) (77%)
Popularity Index:11


10:38
Back HealthyMind Forum
Share tips and experience with other users and the therapists
Threads
Comments
Gallstone
A 2.5cm gallstone was found in my body. Not sure if I need surgery (created 6 days ago by Rafael)
2 posts
Latest: 5 days ago by Rafael
Sport to release stress
I prefer doing sport whenever I stress or have lot tensions (created 6 days ago by qb)
1 posts
Latest: 2 days ago by Jimbobthomas
Taking naps help!
I think taking power naps can help me relieve stress the most! A good quality
3 posts


10:37
Back HealthyMind Forum
HealthyMind Forum
Share tips and experience
Share tips and experience with other...
5 Threads created
Latest by Rafael 6 days ago
Questions and Answers
Ask questions to other users and the..
4 Threads created
Latest by Rafael 6 days ago
Get to know other users
Introduce yourself and get to know o...
17 Threads created
Latest by Joe 3 days ago
Refresh Now


10:38
Back HealthyMind Forum
deep breath
I think I can take a deep breath when I feel nervous. many people say meditation is one of the best way for dealing stress. (created 8 days ago by Andy)
1 posts
Latest: 3 days ago by Vangelis
Drinking coffee makes me feel sleepy!
I know most people drink coffee so as not to fall asleep. In my case it's the contrary. What about you guys? (created 14 days ago by Roushdat)
4 posts
Latest: 3 days ago by Vangelis
New Thread

Appendix G: Post-Study Questionnaire

UNIVERSITY OF Southampton

Questionnaire (version 1, 11/08/2016)

Study Title: Social Media Features Usability and Impact in Digital Behaviour Change Interventions

Investigator's Name: Sheik Mohammad Roushdat Ally Elaheebocus

ERGO Study ID number: 23401

Please answer all the questions in this questionnaire.

Question 1.

The 'Healthy Mind' Application gave me all the advice I needed

	Strongly Disagree									**Strongly Agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
The 'HealthyMind' Application was helpful to me										
I found the 'HealthyMind' Application easy to use										

Forum Component

Question 2.

How did you feel about using the Healthy Mind application with and without the '**Forum**' component? (Tick **one** of the options below)

- ☐ I preferred using the application with the forum.
- ☐ I preferred using the application without the forum.
- ☐ It made no difference whether there was a forum or not

Question 3.

Did you post a question / or shared something on the **'Forum'**? Yes / No *(please encircle your chosen answer)*

Question 3.1.

Briefly tell us why?

_____

_____

_____

Question 4.

Did you find the '**Forum'** helpful? Yes / No *(please encircle your chosen answer)*

Question 4.1.

If you answered Yes, briefly tell us how was the '**Forum**' helpful? Else, if you answered No, briefly tell us why you did not find the '**Forum'** helpful.

_____
_____
_____

Question 5.
Which components and/or aspects did you like about the '**Forum'**?

_____
_____
_____

Question 6.
When I used the '**Forum'**, it made me feel: (select all that applies; you may select multiple statements)

	Strongly Disagree									**Strongly Agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
anxious (e.g. about what others will reply)										
curious (e.g. about the responses of other participants)										
discouraged (e.g. by other participants messages)										
embarrassed (e.g. **t**o share my experience with others)										
happy (e.g. to share my experience with others)										
motivated (e.g. when I read when other participants are doing) **satisfied** (e.g. that I am doing as well or even better than other participants)										
supported (e.g. by other participants though their advice and encouraging messages)										
Other:_____ _____ _____ **(please describe)**										

Question 7.
Please fill in the ratings based on whether you strongly agree or disagree with each statement in relation to the '**Forum'** feature that you have used in the mobile application.

	The statements below all refer to the Forum' feature that you have used in the mobile application.	**Strongly Disagree**				**Strongly Agree**
		1	**2**	**3**	**4**	**5**
1	I think that I would like to use the Forum frequently.					
2	I found the feature unnecessarily complex.					
3	I thought the feature was easy to use.					
4	I think that I would need the support of a technical person to be able to use this feature.					
5	I found the various functions in this feature were well integrated.					
6	I thought there was too much inconsistency in this feature.					
7	I would imagine that most people would learn to use this feature very quickly.					
8	I found the feature very cumbersome to use.					
9	I felt very confident using the feature.					
10	I needed to learn a lot of things before I could get going with this feature.					

Popular Tools Component

Question 8.
How did you feel about using the Healthy Mind application with and without the **'Popular Tools'** component? (Cross **one** of the options below)

- ☐ I preferred using the application with the 'Popular Tools' component.
- ☐ I preferred using the application without the 'Popular Tools' component.
- ☐ It made no difference whether there was a 'Popular Tools' component or not

Question 9.
Did you find the **'Popular Tools'** component helpful? Yes / No *(please encircle your chosen answer)*

Question 9.1.
If you answered Yes, briefly tell us how was the **'Popular Tools'** helpful to you? Else, if you answered No, briefly tell us why you did not find the **'Popular Tools'** helpful.

_____
_
_____
_

Question 10.
Which components and/or aspects did you like about the **'Popular Tools'**?

_____
_____
_____

Question 11.
When I used the '**Popular Tools'** feature, it made me feel: (select all that applies; you may select multiple statements)

	Strongly Disagree									**Strongly Agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
anxious (e.g. about what others will reply)										
curious (e.g. about the responses of other participants)										
discouraged (e.g. by other participants messages)										
embarrassed (e.g. **t**o share my experience with others)										
happy (e.g. to share my experience with others)										
motivated (e.g. when I read when other participants are doing) **satisfied** (e.g. that I am doing as well or even better than other participants)										
supported (e.g. by other participants though their advice and encouraging messages)										
Other:_____ _____ _____ **(please describe)**										

Question 12.

Please fill in the ratings based on whether you strongly agree or disagree with each statement in relation to the **'Popular Tools'** feature that you have used in the mobile application.

	The statements below all refer to the 'Popular Tools' feature that you have used in the mobile application.	**Strongly Disagree**				**Strongly Agree**
		1	**2**	**3**	**4**	**5**
1	I think that I would like to use the 'Popular Tools' feature frequently.					
2	I found the feature unnecessarily complex.					
3	I thought the feature was easy to use.					
4	I think that I would need the support of a technical person to be able to use this feature.					
5	I found the various functions in this feature were well integrated.					
6	I thought there was too much inconsistency in this feature.					
7	I would imagine that most people would learn to use this feature very quickly.					
8	I found the feature very cumbersome to use.					
9	I felt very confident using the feature.					
10	I needed to learn a lot of things before I could get going with this feature.					

Question 13.

	Extremely Unlikely									**Extremely Likely**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How likely are you to continue using the 'HealthyMind' Application after this study ends?										

Question 14.
Please share any other thoughts or comments about the 'HealthyMind' App.

_____

_____

Question 16.

Please rank the following additional options/functionalities that you would have liked to be included in the 'HealthyMind' mobile application. (With 1 being the most desired and '5' being least desired)

- Sharing on Facebook /Twitter or other online social network
- Live chatroom
- Your own user profile with picture/avatar
- Ability to view other participants profile
- Peer notification (e.g. getting to know when other participants are using the different tools or posted on the forum for example)

Thank you for completing this questionnaire.

Appendix H: Interview Questions Guide

Follow up questions (To be adapted with the answers provided through the online questionnaire)

- Tell us a bit more how the 'HealthyMind' mobile Application was helpful to you?

- Did you notice the changes in terms of functionalities with the new version of HealthyMind for the second week?

- Tell us a bit more why you did not post any comments or create any new thread on the forum?

OR

- Although you posted on the forum, you did not participate in any discussions there; could you please elaborate why?

- What do you think could have been done to make you feel more interested in using the Forum or Popular Tools feature? [more participants? reminders? notifications?]

For Cherry->Plum

- Tell us how you felt when you found that there was no Forum and Popular Tools feature in the 2nd Version?

- Do you feel that it made a difference for you when the forum & popular feature were provided to you in the first week but then removed in the second version?

For Plum -> Cherry

- Tell us how you felt when you found that there were additional features, namely a Forum and a Popular Tools feature in the 2nd Version?

- Do you feel that it made a difference for you when the forum & popular features was not provided to you in the first week and then introduced in the second version?

Additional questions based on answers provided in questionnaire.
Do you have any other comments/ suggestions about the mobile application, the forum, or the popular tools feature?

Appendix I : Sample Intervention Configuration File (JSON)


```
{
	"interventionID": "evaluationwithstd",
	"groups": [
		0
	],
	"content": {
		"applicationName": "HealthyMind",
		"front": "FrontMenu",
		"launchItem": "Healthy Mind: Baseline",
		"launchFunction": "toolUnlockInitialise",
		"logo": "logo.png",
		"icon": "icon.png",
		"notifIcon": "icon.png",
		"theme": "healthy",
		"modelVersion": "1",
		"periodicDownloads":{
			"updatePeriod":30,
			"wifiOnly":false,
			"periodicJobs":[
				{
					"pdjobid":"statsall",
					"outputfile":"current_intervention_ts.json"
				},
				{
					"pdjobid":"statsuserwise",
					"outputfile":"current_intervention_ts_userwise.json"
				},
				{
					"pdjobid":"statspollsimple",
					"outputfile":"current_intervention_poll_results.json"
				}
			]
		},
.
.
.
{
	"id": "toolStats",
	"type": 5,
	"label": "Popular Tools",
	"navCondition": {
		"op": "=",
		"varA": "v-connect",
		"varB": "unlock"
	},
	"navConditionFail": 0,
	"content": {
		"items": [
			{
				"id": "polltstats",
				"type": 1,
				"label": "Select Option",
				"content": {
					"questions": [
						{
							"title": "Data View Preference",
							"text": "Tools' are ranked in terms of the
```


percentage of number of times that they have been used over the total number of tools usage or the percentage

of positive ratings for a particular tools compared to negative ratings. Would you like to view tools' popularity based on your own data only or that of all participants'?",
"footerText": "You can try the other option afterwards",
"details": [
"Popularity calculation will make use of only your data ",
"Popularity calculation will make use of all participants' data"
],
"choices": [
"Own Data",
"All Participants"
],
"type": 1,
"question_id": 1
}
]
}
},
{
"id": "tstats",
"type": 33,
"label": "Tools Ratings",
"content": {
"type": 2,
"title": "Tools Popularity",
"text": "This is a tools statistics page.

Click 'launch' to try the tools.",
"sortUsage":true,
"sortRatings":true
}
}
]
}
}

Appendix J : Task List for Evaluating the Usability of the Authoring Tool

UNIVERSITY OF Southampton

Tasks List (Version 1, 07/11/16)

Study Title: Evaluating the Usability of an Authoring Tool for Behavioural Interventions That Facilitate the Inclusion of Social Media Features

Investigator's Name: Sheik Mohammad Roushdat Ally Elaheebocus
ERGO Study ID number: 24332

Please use the Authoring Tool to carry out the following Tasks while thinking aloud:

Task 1

- Add an **Online Forum** to the existing Intervention
- Create two topics in the forum
- For topic 1, enable moderation for new threads and comments
- For topic 2, no moderation required but thread creations can only be done by the intervention experts (super-users) **Task 2**

Task 2

- Add a **Statistics** Item to the existing Intervention with the identifier '*appusage*'
- Customise the item to display usage '*as a percentage'*
- Select the sorting method 'By number of Participants'
- The recalculation rate for usage on server should be set to 30 minutes while the refresh rates on devices should be 60 minutes.

Task 3

Select the following items for tracking and which will be displayed in the 'appusage' statistics item by clicking on the 'Tracking' tab for each corresponding item:

- About intervention info page

Ensure that the usage data tracked will be also displayed on the client app (users phones) by selecting the corresponding checkbox.

Appendix K : Questionnaire for Evaluating the Usability of an Authoring Tool

UNIVERSITY OF Southampton

Questionnaire (version 1, 07/11/2016)

Study Title: Evaluating the Usability of an Authoring Tool for Behavioural Interventions That Facilitate the Inclusion of Social Media Features

Investigator's Name: Sheik Mohammad Roushdat Ally Elaheebocus

ERGO Study ID number: 24332

Please answer all the questions in this questionnaire.

Question 1.

Please rate the complexity levels of each of the following tasks that you undertook.

	Extremely Complex									**Extremely Simple**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Creating and customising the forum.										
Creating and customising the statistical feature.										
Specifying items that required tracking.										

Question 2.
Please fill in the ratings based on whether you strongly agree or disagree with each statement in relation to the Authoring Tool when undertaking the different tasks.

		Strongly Disagree				Strongly Agree
		1	**2**	**3**	**4**	**5**
1	I think that I would like to use the Authoring Tool frequently.					
2	I found the Authoring Tool unnecessarily complex.					
3	I thought the Authoring Tool was easy to use.					
4	I think that I would need the support of a technical person to be able to use this Authoring Tool.					
5	I found the various functions in this Authoring Tool were well integrated.					
6	I thought there was too much inconsistency in this Authoring Tool.					
7	I would imagine that most people would learn to use this Authoring Tool very quickly.					
8	I found the Authoring Tool very cumbersome to use.					
9	I felt very confident using the Authoring Tool.					
10	I needed to learn a lot of things before I could get going with this Authoring Tool.					

Bibliography

1. Yardley, L., et al., *Current issues and future directions for research into digital behavior change interventions.* American journal of preventive medicine, 2016. 51(5): p. 814-815.

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