CORA Cork Open Research Archive
Cartlann Taighde Oscailte Chorcaí

Title	A systematic review of user-centred design practices in illicit substance use interventions for higher education students
Authors	Organ, Damien;Dick, Samantha;Hurley, Caroline;Heavin, Ciara;Linehan, Conor;Dockray, Samantha;Davoren, Martin P.;Byrne, Michael
Publication date	2018-06-01
Original Citation	Organ, D., Dick, S., Hurley, C., Heavin, C., Linehan, C., Dockray, S., Davoren, M. and Byrne, M. (2018) 'A systematic review of user-centred design practices in illicit substance use interventions for higher education students', European Conference on Information Systems 2018: Beyond Digitization - Facets of Socio-Technical Change, Portsmouth, UK, 23 - 28 June.
Type of publication	Conference item
Link to publisher's version	http://aisel.aisnet.org/ecis2018
Rights	© 2018, the Authors. Published by AIS Electronic Library (AISeL)
Download date	2026-11-16 19:28:25
Item downloaded from	https://hdl.handle.net/10468/6859

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

A Systematic Review of User-Centred Design Practices in Illicit Substance Use Interventions for Higher Education Students

Research Paper

Organ, Damien, University College Cork, Cork, Ireland, damien.organ@ucc.ie.

Dick, Samantha, University College Cork, Cork, Ireland, samantha.dick@ucc.ie.

Hurley, Caroline, University College Cork, Cork, Ireland, caroline.hurley@ucc.ie.

Heavin, Ciara, University College Cork, Cork, Ireland, c.heavin@ucc.ie.

Linehan, Conor, University College Cork, Cork, Ireland, conor.linehan@ucc.ie.

Davoren, Martin, University College Cork, Cork, Ireland, m.davoren@ucc.ie.

Byrne, Michael, University College Cork, Cork, Ireland, m.byrne@ucc.ie.

Abstract

There is increasing interest within the mobile health (mHealth) field for technologies that encourage users to change or avoid certain health related behaviours. Recently the area of illicit substance use has attracted the attention of mHealth researchers, particularly as illicit substance use among students in higher education appears to be increasing. Little analysis has been conducted on the design strategies used to develop these interventions and the user experience they deliver. With concern growing about the capacity of mHealth interventions to engage users in real world settings, we undertook a systematic review of the implementation and reporting of user-centred design (UCD) practices in the development of illicit substance use behavioural interventions in the higher education context (n=7). Our review revealed limited consideration of end user experience and minimal engagement with UCD practices. We argue that these studies do not give sufficient consideration to factors that would have a significant influence their effectiveness and sustainability in normal use conditions. We further propose a framework of guidelines for the design and reporting of mHealth interventions (SCENE) that will underpin more robust methodologies for developing, evaluating, and reporting intervention strategies in this context.

Keywords: mobile health (mHealth), user-centered design (UCD), intervention, higher education, substance use.

1. Introduction

A core goal of many mHealth technologies is to change the behaviour of users; to encourage users in the adoption of behaviours which are beneficial to them, and to avoid behaviours which are harmful (Orjii and Moffatt 2016). In order to design technologies which can meet these ambitious aims, collaboration between a wide range of both academic disciplines and practitioners is required, from public health, to psychology, to interaction design and information systems (Kelders et al. 2016). This is because the human decisions that relate to health outcomes are multifaceted in nature, and are enacted within complex and dynamic contexts. Successful interactive technologies and behavioural change systems are not simply usable, rather they provide engaging experiences that are highly sensitive to the use context, particularly the expectations, goals, motivations, and needs possessed by their users (O'Brien and Toms 2008, Doherty et al. 2010). The need to better understand the 'real world' context of interventions is increasingly recognised as critical if the vast potential of mHealth technology is to be fulfilled (Collins 2012, Tomlinson et al 2013, Glasgow et al. 2014).

The development of engaging experiences for the users of mHealth technologies first requires an interest in the nature of those experiences (Wright and McCarthy, 2010; Hassenzahl et al. 2010). If users are to be engaged beyond closed research settings, then developers of mHealth technology must employ research and design processes through which they can work productively with users in order to understand their daily experiences, values, and habits (Wright and McCarthy 2010). A set of practices and processes has emerged for carrying out exactly this type of work, which are collectively referred to as user-centered design (UCD) (Norman 1986, Gulliksen et al. 2003, Schnall et al. 2016). Core principles of the UCD approach include the adoption of a user focus (the users' goals, tasks and needs should guide early development), active user involvement in evaluation and design throughout the entire development process, and the evaluation of use in the context of real user goals and environments (Nielsen 1994, Gould 2000, Gulliksen et al. 2003). The importance of a UCD approach to health outcomes has begun to attract attention in the mHealth domain as both researchers and practitioners have started to grapple with the failure of many mHealth technologies to engage users, leading to the underutilization of tools that have been developed at considerable expense (Tomlinson et al. 2013, Kellerman and Jones 2013, de Alva et al. 2015, Schnall et al. 2016).

College is a transitional period for many young adults, and is associated with peak levels of experimentation and risk-taking (Ford and Arrastia 2008, Sussman and Arnett 2014). University health services, however, and in particular mental health services experience very high clinical loads which severely limit their capacity for face-to-face interventions (Gulliver et al. 2015). mHealth technologies have been advanced as a means of overcoming this challenge (Boumparis et al. 2017). In this paper we conduct a systematic review of the implementation and reporting of user-centred design (UCD) processes in the development of illicit substance use interventions in the higher education (HED) context. Our review of seven intervention studies attempts to establish an understanding of the nature of the user experience in this domain, and the design strategies most likely to engage users in a real world setting. Examining five distinct elements of the design process, our review revealed limited consideration of end user experience and at best weak engagement with UCD practices. None of the studies in our review reported an examination of user expectations, goals, motivations, or needs in either the literature or within their own study. Of the five full intervention reports within the review, none reported any engagement with end users in the design process. Post-hoc user evaluation of the system piloted was not reported in three of the seven of the studies we reviewed. Where present, it focused only on generic measures of satisfaction or utility, with no exploration of more context specific issues nor fundamental facets of the experience of engaging with interactive products such as stimulation, relatedness, competence, or security-control (Hassenzahl et al. 2010). In short, the designers of the systems we reviewed seemed largely unconcerned with the experiences of users. We suggest that the limited consideration of user experience and weak engagement with UCD processes revealed in our

review may help to explain the high rates of user attrition, low adherence to therapeutic programmes, and in general low usage of mHealth technologies found in multiple previous analyses (Eysenbach 2005, Kelders et al. 2012, Murray et al. 2013, Guertler et al. 2015, Whitton et al. 2015, Ryan et al. 2017).

We further advance five UCD based intervention design and reporting guidelines, centred on **S**etting, **C**ontext, **E**ngagement, **N**arrative, **E**valuation (SCENE) for mHealth interventions which we develop on the basis of this review. We argue that the implementation of these practical guidelines will underpin more robust methodologies for developing, evaluating, and reporting intervention strategies in this context, while requiring only minimal additional resources for their inclusion. Exploring and reporting the socio-emotional context of users, and evaluating their experiences through well-established UCD techniques will greatly improve researchers' understanding of why behavioural intervention strategies did or did not work, helping to open the 'Black Box' (Kelders et al. 2016) which has severely hampered the development of the field. Our proposals echo previous calls from implementation science that researchers must go beyond summary evaluations of endpoint outcomes within intervention studies, and more rigorously assess the extent to which an intervention is effective and sustainable in a specific real world context (Damschroder et al. 2009). We conclude by stating that the demand for mHealth technologies is likely to intensify in the future, and that if academic researchers fail to rise to the challenge of designing interactive experiences that engage users beyond the research setting, less rigorous industry led initiatives will fill the gap.

2. Theoretical Framework

2.1 mHealth interventions in the illicit substance use domain

Currently, one-quarter of European 18-21 year olds and 41% of 21-24 year olds report illicit substance use in their lifetime, with the substances used including cannabis, amphetamines, MDMA, opiates, cocaine, crack and mushrooms (EMCDDA 2011). The most widely used psychoactive substance is cannabis, the use of which by young people can have both long-lasting behavioural and physical consequences, such as brain development complications, bronchitis, attention and memory impairment, and depression (Tonneson et al. 2013). Other widely used illicit substances such as MDMA, LSD, and cocaine can lead to conditions such as heart rate irregularities, heart attack, abdominal pain, vomiting, constipation, diarrhoea, kidney and liver damage, seizures, and strokes (Newcomb and Bentler 1986). Rates of illicit drug use peak in adolescence and young adulthood, with college and university students representing a particularly high risk group within this population (Johnston et al. 2005). Illicit substance use is also intertwined with physical and mental health in the HED context. Individuals who report poor physical and mental health also reporting higher levels of substance use, with the latter often exacerbated by the former (Hser et al. 2001).

Reducing the harms which arise from illicit substance use in this population remains a major challenge for both public health policy and for practitioners in this domain. Only 20% of individuals with substance use disorders utilize mental health and addiction services, with low availability of treatment services, overcrowded programmes, time conflicts, financial barriers, and social stigma all exacerbating the phenomenon (Boumparis et al. 2017). Reflecting the challenges recognised in the mHealth field more broadly, little if any analysis has been conducted on the interactive design of these interventions. In addition, the targeting of young adult populations on the basis of their familiarity with the underlying technology seems to raise its own challenges. While receptiveness to internet applications may be much higher, performance expectations are likely to be as well (Eysenbach et al, 2008, Thomas 2011). Given the significant user engagement challenges observed within the mHealth domain more broadly (Schnall et al. 2016), it is important to ask that in addition to the general public health goal of harm reduction, what user experience elements are considered in the design of interventions in this space? With interest growing in the potential for mHealth to impact upon what is a very significant public health question,

such an examination may be needed. This is also important to the broader consideration of the integration of context, content, and system within the design of behavioural change support systems, where disciplinary fragmentation has emerged as significant obstacle to the field's development, prompting calls for a holistic, integrated analysis (Kelders et al. 2016).

2.2 User-centred design in mHealth

The potential for mHealth to transform modern health service provision has justifiably attracted the attention of researchers from a broad range of disciplines, with studies of health behaviour change support systems appearing in information systems, psychological, and public health conferences and journals. Kelders et al. (2016) argue that while each discipline has produced crucial insights that have contributed to the development of the field, the disparate approaches utilised seem to have fostered the 'Black Box' problem, with insight regarding whether or not online interventions work, but no more than limited insight into how and why they work. In establishing this argument they point to the difficulties encountered in attempts to systematically review specific domains within the field, where both variation in emphasis on intervention elements and divergent application of terminology has severely hampered the execution of coherent reviews (see Morrison et al. 2012). The importance of an integrated approach is increasingly recognised as central within design research, wherein the necessity of interactive products addressing the whole user experience has become a central consideration (Forlizzi and Battarbee 2004, Wright and McCarthy 2010). While agreed definitions of user experience are elusive, a clear transition has occurred within study of human-computer interaction (HCI) that has shifted the focus of design from a task focus to a user focus. The result of this shift has been a recognition that in order for engaging software systems to be developed, an understanding of what the end users of the system actually want the system to do for them must be prioritised (Wright and McCarthy 2010). A better understanding of the user's interaction with the technology, the emotions produced by the interaction, and what outcomes matter most to the users is more likely to lead to technologies that improve the lives of those that use them and motivate continual user reengagement (Forlizzi and Battarbee 2004, Hassenzahl et al. 2010).

There is growing support for this perspective within the mHealth literature. Geng et al. (2017) argue that even if the findings from intervention evaluation studies have internal validity, this does not mean that they are useful to those who have to implement them in real world settings. It is not enough to analyse mHealth interventions only in terms of their impact on behaviours and attitudes in a closed research setting, researchers must evaluate the sustainability of the intervention in a real world context (Damschroder et al. 2009). The utility of UCD in this sense is supported Van Gemert-Pijnen et al. (2011), who found that the participatory involvement of end users in the development of mHealth applications resulted in better adherence to technologies and fewer errors and misinterpretations of requirements. Despite this, there has been little or no systematic analysis of how UCD is used in the development of mHealth interventions, or how researchers employ user experience insights to create engaging experiences (Perski et al. 2016, Yardley et al. 2016, Taki et al. 2017). Given that that interventions in this domain are typically driven by the public health goal of harm reduction, it seems possible that satisfaction of the expectations, goals, motivations, and needs that comprise the experience of interacting with a computer application (McCarthy and Wright 2004) are frequently given inadequate consideration – both in the design process and in the reporting of outcomes. Failure to consider these factors will at best confound analysis of their effectiveness, as not enough is known about the design process to properly assess intervention strategies, and at worst undermine their effectiveness in reducing the serious harms associated with illicit substance use.

To address this gap, our review addresses two questions: (1) How have UCD practices been employed in the development of illicit substance use interventions in the HED context, and (2) what user insights do previous intervention studies provide that would inform the development of technologies that will engage users in the real world setting? The review is intended to contribute to the future development

of illicit substance use interventions for the HED setting in particular, and more broadly to the development of engaging and sustainable mHealth interventions through the implementation and reporting of UCD practices.

3. Methods

3.1 Search Methods

We conducted a literature search of the following databases using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher et al 2009): Scopus, PyscInfo, PubMed, Medline, Cochrane, Sage, and ERIC. Our search employed Boolean search methods using and/or combinations for searching key words and terms. The complete list of search terms used is provided in table 1. Full paper articles, abstracts, and study protocols were considered in our search. The final updated search was performed on November 7th, 2017. Our eligibility criteria were as follows: (1) that the intervention was aimed at illicit substance use, (2) that the intervention was aimed at a higher education population, (3) that the intervention was internet-based, and (4) that the study was published in the English language.

Concept 1 - Substance Use	**Concept 2 - Intervention**	**Concept 3 - Internet**	**Concept 4 - Population**
Substance use	intervention	internet	college students
substance abuse	treatment	web based	students
illicit substance	therapy	internet supported	university students
psychoactive drugs	programme	ehealth	
marijuana	counsellor	information technology	
recreational drugs	therapist	mhealth	
illicit drugs	tracker	mobile application	
cannabis	counselling	online	
drug use	mentor	text messages	
	coach	web application	
	diary	mobile	
	behaviour change		

Table 1. Key words and terms used in literature search

3.2 Search Results

Our initial literature search returned 799 results (see figure 1). After the removal of duplicate records, a total of 377 citations remained. Two researchers screened the titles and abstracts of these records against our study's eligibility criteria. Of the 377 records screened, a further 359 were excluded as they did not meet the inclusion criteria, leaving 18 records eligible for assessment of the full text. Two researchers then independently reviewed the 18 remaining articles, with a final consensus reached on the inclusion of 7 articles in the review. No additional articles were found through hand searches.

3.3 Data Extraction and Analysis

We included five distinct factors in our analysis. Firstly we analysed the interaction setting, or the circumstances within which users in the studies encountered the intervention, and whether attempts were made to understand their motivation for engagement. Secondly, we analysed the alignment of the intervention with the socio-emotional context, and the specific user expectations, goals, motivations, and needs found to have salience in this setting. Thirdly, we analysed engagement of users in the design process, the techniques through which potential end users were engaged and the testing of design concepts. Fourthly, we analysed the narrative framing of the intervention, and the manner in which the

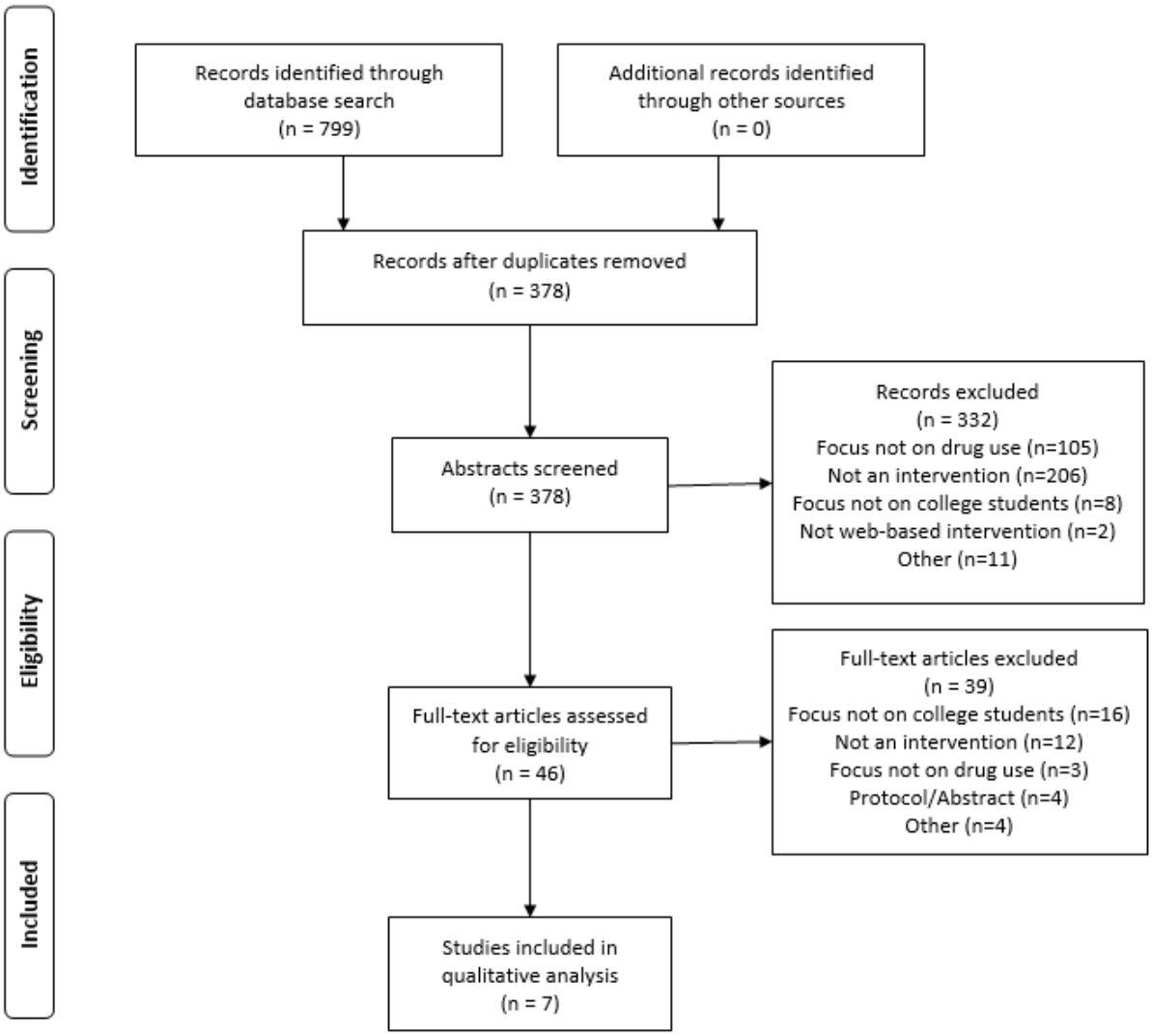


Figure 1. Study Search Process

purpose of their participation was framed for the students in the study. Fifthly, we analysed the post-hoc student evaluation of the intervention, in particular how their opinions and reflections were collected, and what the focal points of this reflection were. Our data extraction protocol defined data as the second order constructs of researcher statements and descriptions of procedures (Toye et al. 2014). The researchers independently coded each text for each of the five criteria, then compared the text extracted. At this point the extracted texts were discussed and analysed by the users in the context of each theme. The results of this analysis are presented in the following section,

4. Findings

The characteristics of the seven articles are presented in table 2. Of the articles reviewed, five were reports on the trial of a behavioural change intervention for illicit substance use in higher education populations, while two described protocols for studies in the same setting. In total six different applications were described, with two using the same application for their separate studies (Palfai et al. 2014 and Elliot et al. 2014). Each paper was independently analysed by two researchers in terms of the five UCD considerations identified in the previous section.

4.1 Interaction Setting

All seven studies either employed or planned to employ direct invitation in their recruitment of participants for their studies. Two studies offered financial incentives to participants in order to sustain engagement. None of the studies considered volunteer bias, nor conducted any analysis of their participants' motivation to engage in the study. As such it is not possible to characterise any of the studies in terms of the needs, motivations, expectations, or goals of their participants.

4.2 Alignment of Intervention with the User Context

None of the seven studies reported any analysis of the user context of the intervention, either in terms of the study population's behaviour or the literature. The sole reference to user needs found across all seven studies was the access benefits of an electronic service. No description nor review of student motivation for engaging in substance use screening or assessment was reported by any of the seven studies. Nor did we find any reference to more fundamental facets of the experience of engaging with interactive products such (Hassenzahl et al. 2010). Finally, no study made reference to the intervention qualities that users were likely to expect. Given the very limited consideration of the user context in the studies, it was not possible for us to identify any strategies to align the intervention with it for the purposes of enhancing the user experience.

4.3 Engagement of Users in the Design Process

Of the five intervention reports in our review, none reported any engagement of users in their design process. We searched for references to workshops, evaluation of intervention components, or background information gathering with a view to defining either the intervention use context or the likely end user. Only the two study protocols made reference to any of these elements, with Pischke et al. (2012) and Helmer et al. (2016) both indicating their intent to employ focus groups or discussion groups in their presented protocols. Neither of these studies provides greater detail in terms of UCD methodologies they plan to implement in these activities, however the former does refer to specific components of the intervention that they intend to subject to user evaluation.

4.4 Narrative framing of the intervention purpose.

None of the studies report the narrative framing within which the intervention will be presented to the users. While the majority of the studies refer to their framing of the 'study' or 'research' purpose to the students in their sample, that framing is not reported in any case within the procedural descriptions. We therefore cannot assess how and to what extent end user expectations were shaped by the researchers, and how the end users subsequently understood the purpose of their engagement with the intervention. For example, it is not clear whether the majority of the participating students in any of the studies understood the experience as a means of fulfilling existing needs with respect to illicit substance use, or as contributing to the development of socially beneficial service.

4.5 Evaluation of the user experience

Four of the seven studies described at least some form of post-hoc evaluation in their protocols for the purpose of understanding the user experience. Three studies described measures for evaluating user satisfaction with the intervention (Donovan et al., Palfai et al., & Elliot et al.), while Elliot et al. and Helmer et al. also described protocols for the evaluation of the usability and utility of various components of the intervention. None of the studies described evaluation of the interventions in terms of deeper elements of the user experience, such as specific needs fulfilment, positive and negative affect, or the meaningfulness of the interaction. Nor did any study report evaluation of the quality of engagement (eg. interesting content or interactivity), aesthetics (eg. layout, style, visual appeal), or information quality (eg. credibility or presentation style).

Authors	Paper	Engagement Setting	Contextual Analysis of Needs	User Engagement in Design Process	Narration/Framing of Intervention	Post-Hoc User Evaluation
de Oliveira et al. 2015	Intervention report	Direct invitation, Motivation not reported	None reported	None reported	Not reported	None reported
Donovan et al. 2012	Intervention report	Direct invitation, Motivation not reported	None reported	None reported	Not reported	Satisfaction
Elliot et al. 2014	Intervention report	Direct invitation, Motivation not reported	None reported	None reported	Not reported	Satisfaction Utility (some elements)
Helmer et al. 2016	Study Protocol	Direct invitation, Motivational analysis not planned	None reported	Focus groups planned	Not reported	Utility (some elements)
Lee et al. 2010	Intervention report	Direct invitation, Financial incentive, Motivation not reported	None reported	None reported	Not reported	None reported
Palfai et al. 2014	Intervention report	In-clinic screening, Direct invitation, Financial incentive, Motivation not reported	None reported	None reported	Not reported	Satisfaction
Pischke et al. 2012	Study Protocol	Direct invitation, Motivational analysis not planned	None reported	Discussion groups planned	Not reported	None planned

Table 2. Summary of Reviewed Papers

5. Discussion and Recommendations

Our review of illicit substance use interventions in the HED context reveal limited consideration of end user experience across five distinct elements of the intervention design process. The weak engagement with best practice in mHealth design principles highlighted in the review has a number of significant implications both for the development of interventions in this space, and for the generalizability of previous findings in this context. We will summarise these and provide recommendations for future work in this section. We also foreground these recommendations with two general comments on the state of the art within this specific domain. Firstly, it is our view that the broad claims about the efficacy of online interventions made in a number of the papers reviewed are not appropriate as the interventions described do not and cannot reflect the broad scope of mHealth systems' capabilities, and should therefore bound their conclusions within the scope of the specific strategies they employed. Secondly, if mHealth intervention studies are to influence subsequent initiatives within their field of interest, then important changes to both the reporting of such studies and the outcomes for which they are intended seem necessary. When designing and evaluating systems with a public health focus, we need to understand how they are encountered naturally and in context (Gulliksen et al. 2003, Glasgow et al 2014) – recruiting people intentionally to a study undermines the 'public' nature of the intervention and is a limitation that requires careful consideration.

The study design for the reviewed papers represents a broader trend within mHealth of the elimination of contextual confounders, when that context represents the normal conditions within which the intervention must work (May et al 2016). mHealth interventions must attract and engage users on their own merits, beyond the research setting (Rogers 2011). If the studies in our review gained insights into how such engagement could be generated, they largely fail to report it. User expectations, goals, motivations, and needs were neither explored nor documented. This is not superfluous information, but in fact integral to robust design processes that will produce interventions which deliver engaging experiences through the satisfaction of fundamental user needs (Hassenzahl et al. 2010, Wright and McCarthy 2010). We acknowledge the complexity of context, and that user experience is multidimensional, with aesthetic, cognitive, emotional, physical, and sensual components (Forlizzi and Battarbee 2004). Our criticism is not that researchers have failed to encompass all of these elements in each of their studies, rather it is that even if one adopts a simple task-centred perspective of the design approaches we reviewed, even those have not been informed by a user-centred analysis. Failure to consider and report this dimension of the study, and of the use context, will only compound the broader mHealth challenge of weak user engagement, poor adherence, and low retention (Eysenbach 2005, Kelders et al. 2012, Guertler et al. 2015, Whitton et al. 2015). On the basis of our review, we advance the SCENE guidelines for the design and reporting of online interventions in the illicit substance domain. We elaborate on these guidelines in our recommendations section.

5.1 Recommendations

Setting: *Report and consider the impact of interaction setting on the study's results.*

Our first recommendation is that researchers give greater consideration to the context of interaction within which the intervention is tested. A key point to consider is that the research setting removes many of the most fundamental challenges to user engagement, i.e. the distracting stimuli of the natural setting and the apathy, disinterest, and avoidance that have proven so challenging for the implementation of mHealth technology (Guertler et al. 2015, Taki et al 2017). There are considerable differences between the experience of encountering an application in day to day life on one's own volition, and engaging with an intervention that has been presented in a study to which you have been recruited (Rogers 2011). On this point, it should also be acknowledged that an individual's motivation to participate in a research study is likely quite different from their motivation to engage with a harm

reduction application related to drug use (Kelders et al. 2012). We propose that as a simple corrective measure researchers explore respondents' motivation for participating in their study through survey methods. The starting point for researchers should be to describe the specific goals and motivations of a typical real world user, or preferably multiple types of users. The goals and motivations of study participants can be compared with these types, providing a much greater sense of how relevant their outcomes are beyond the closed research setting. Furthermore the validity of these user types can be greatly strengthened by the generation of personas and user stories through deeper exploration of the user context, the absence of which creates considerable uncertainty about how to interpret intervention outcomes.

Context: *Investigate the socio-emotional context of user engagement with the intervention.*

Our second recommendation is that greater efforts are made to identify the socio-emotional user context in advance of their participation in intervention trials (Doherty et al. 2010). None of the papers in our review reported any analysis of, for example, help or information seeking behaviour with respect to illicit substance use on the part of the population targeted in their studies. Nor was there any consideration of more fundamental facets of user experience that would better document the users' sense of what needs the intervention would satisfy. This left the underlying emotional dynamics of user interaction with the intervention unexplored and unconsidered. This is especially problematic as it is difficult to contextualise the user's interaction with the intervention in the absence of some sense of their motivations, needs, goals, or expectations (Hassenzahl et al. 2010, Wright and McCarthy 2010). We propose that future studies could make an important contribution to the literature by offering a considered analysis of at least one of these four variables, and by describing the manner in which their intervention aligns itself with the specified context. This will improve understanding of the results of individual studies and trials, and contribute to a wider understanding of what underpins user adherence and satisfaction in the domain more generally (May et al. 2016, Taki et al. 2017).

Engagement: *Engage users in the design process through participatory design methods*

Our third and overarching recommendation is that engagement with potential end users of the intervention (in this case higher education students) is initiated during the design of the intervention itself. Extensive analysis of participatory methodologies has been conducted over the past two decades with a great number of techniques now available to developers of mHealth technologies (Muller 2003, Doherty et al. 2010, Wright and McCarthy 2010). We would encourage researchers to apply these techniques to assist in the initial definition of the problem that is being solved and in the development of the earliest outlines of a proposed solution. In particular we recommend that the distinction between the intervention objectives and the end user needs that motivate their engagement are understood. Whereas the intervention objective may seem abstract and distant, the personal need is immediate, relevant, and motivating.

The distinction between the objective and the need is critical as the gap between the two criteria is likely to influence both the decision to engage with the intervention in a real world setting as well as the extent to which the user will feel their particular need was addressed. Key frameworks at this stage include personas and user stories or journeys. Personas are fictional but representative archetypes of target users that describe who the user is, incorporating their goals, needs and concerns. A user story or story describes the process through which a particular need arises and the experience of the persona as they attempt to resolve this problem. It captures the goals, actions, thoughts, and emotions of the persona as they engage with the planned intervention. Both these tools should be based on both interviews and workshops with potential users where they themselves describe and sketch both the personas and their stories. Based on such engagement researchers can create empathy maps which describe the problem

from the user's point of view, task flows which describe the process through which they will reach their goal for the interaction, or role-plays which simulate the initial design of the interactive experience.

These are just a few of approaches which can be used to uncover core user needs in the design of interventions (Gulliksen et al. 2003). User involvement in this process will greatly increase the likelihood of correctly anticipating user needs and expectations (Doherty et al 2010, Wright and McCarthy 2010), leading to stronger engagement and higher levels of adherence in the normal conditions of use (Van Gemert-Pijnen et al. 2011, May et al. 2016).

Narrative framing: *Report the narrative framing of the intervention to the participants.*

Our fourth recommendation is that researchers make greater efforts to report the narrative framing of the intervention purpose in the first instance, and secondly to explore the impact of different frames on the user experience. At the most basic level, it matters greatly to our interpretations of the results of these studies whether participants feel that they are contributing to a personal or scientific goal. If students feel that the purpose of their engagement is that they are assisting in the development of socially beneficial service, then their evaluation of that experience is likely to differ from their evaluation of an experience where personally defined needs and goals are the primary focus. Individual expectations of what an interaction will deliver are fundamental to our understanding of how they evaluated it and, therefore, the narrative which is built in anticipation of the experience informs the experience itself. (Wright et al. 2003, Hassenzahl et al. 2010).

Evaluation of user experience: *Conduct and report user evaluation of the intervention on multiple levels.*

Our fifth recommendation is that post-hoc evaluation of the user experience is recognised as a central element of the process of piloting interventions in this context, and this evaluation is carried out at a deeper level than simple usability or task utility. There are many directions for such evaluation to take. At the level of user needs, Hassenzahl et al. (2010) point to stimulation, relatedness, competence and popularity having salience and contributing to the overall positive affect experienced by the user. This builds on earlier work by Sheldon et al. (2001) on the psychological determinants of satisfying experiences. The importance of such evaluation is that it takes us beyond knowing if the user found the experience satisfying or not, and allows to examine why the experience was satisfying and what underlying needs are driving the behaviour that is in focus. At the surface level of design, Stoyanov et al.'s (2015) mobile health application rating scale (MARS) allows for evaluation of the application's engagement value, functionality, aesthetics, and information quality. At a minimum, such data would provide much a more comprehensive account of the technical quality of the intervention implemented. It also has the potential for to build a more precise understanding of how much each element contributes to the effectiveness of digitised behavioural change techniques. This has important implications for resource allocation in what are experimental projects.

Without more sophisticated post-hoc evaluation, it is not possible to fully understand the reasons for post-intervention behaviour (Doherty et al. 2010, Morris et al. 2010, Whitton et al. 2015). This is particularly problematic in studies that do not report user involvement in the design process either. To omit both elements provides an intervention project team with no insight into how the intervention is received by users and their willingness to use it. This severely limits both the ability of future researchers to build on previous studies within the field, while also confounding our interpretation of the results generated by the studies themselves. We argue that implementation of the SCENE guidelines we advance here will address the emerging 'Black Box' challenge within HBCSS literature described by Kelders et al. (2016), providing at a minimum a considerably improved understanding of why specific intervention strategies did or did not work.

Conclusion

This paper has systematically reviewed the implementation and reporting of user-centred design (UCD) processes in the development of illicit substance use interventions in the HED context in order to better understand the nature of the user experience in this domain. This research pays particular attention to the design strategies most likely to engage users in a real world setting. As is the case with any study, this paper is not without its limitations. We conducted our search across a wide range of databases, but nevertheless there may be intervention studies that are not indexed by these databases. Although we clearly specified our inclusion criteria and had two researchers independently screen the search results, we cannot completely remove reviewer bias from this process. Additionally the data extraction protocol we developed, being qualitative in nature, carries a risk of contamination by researcher interpretation. While we hope that providing our analytical criteria will enable other researchers to reproduce our review, we acknowledge that there are limits to the transparency of this procedure. In principle, systematic reviews should also be supported by correspondence with the authors of the included studies and subsequent replication and/or reproduction of their results. However, this is not always possible due to resource constraints (Mallet et al. 2012), as was the case in our study. Additionally, previous research highlights the difficulty of such correspondence in studies such as hours, where authors may not be enthusiastic about engaging in detailed questioning of their work (Duvendack and Palmer-Jones 2011).

We find support for broader concerns about the design strategies adopted for mHealth interventions, in particular the lack of attention paid to the design of engaging user experiences and to failure to more rigorously assess the extent to which an intervention would be effective and sustainable in a real world context. We propose that the implementation of the SCENE guidelines would underpin more robust methodologies for developing, evaluating, and reporting intervention strategies in this context. At a minimum this would provide researchers with an enhanced understanding of why specific intervention strategies did nor did not work, while in a broader sense they can guide the development of interventions which deliver interactive experiences more likely to engage users under normal, real world conditions. While the adoption of a UCD approach is sometime characterised as a major shift in the design philosophy of researchers, the SCENE framework we advance would place a minimal additional burden on the authors of intervention studies. By engaging with this framework, these authors would develop mHealth technologies that are more engaging, would evaluate them in a manner that better indicates their sustainability in a real world setting, and would report them in a way that enables future researchers to better understand why they did or did not work, while providing valuable information about the user context.

References

Arria, A. M., Caldeira, K. M., Allen, H. K., Bugbee, B. A., Vincent, K. B. & O'grady, K. E. 2017. Prevalence and incidence of drug use among college students: an 8-year longitudinal analysis. *The American Journal of Drug and Alcohol Abuse,* 43**,** 711-718.

Bingham, T., O'driscoll, C. & De Barra, G. 2015. National Student Drug Survey 2015. *National Student Drug Survey.*

Boumparis, N., Karyotaki, E., Schaub, M. P., Cuijpers, P. & Riper, H. 2017. Internet Interventions for Adult Illicit Substance Users: A Meta-analysis. *Addiction*.

de Alva, F.E.M., Wadley, G. and Lederman, R., 2015, December. It feels different from real life: Users' Opinions of Mobile Applications for Mental Health. In Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction (pp. 598-602). ACM.

Collins, F., 2012. How to fulfill the true promise of "mHealth": Mobile devices have the potential to become powerful medical tools. Sci Am, 307(1), p.16.

Damschroder, L.J., Aron, D.C., Keith, R.E., Kirsh, S.R., Alexander, J.A. and Lowery, J.C., 2009. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implementation science, 4, p.50.

De Oliveira Christoff, A. & Boerngen-Lacerda, R. 2015. Reducing substance involvement in college students: a three-arm parallel-group randomized controlled trial of a computer-based intervention. *Addictive behaviors,* 45**,** 164-171.

Doherty, G., Coyle, D. & Matthews, M. 2010. Design and evaluation guidelines for mental health technologies. *Interacting with computers,* 22**,** 243-252.

Donovan, E., Hernandez, J., Chiauzzi, E., Dasmahapatra, P., Achilles, T. & Hemm, A. 2012. Results of a pilot study to investigate community college student perceptions of the value of an online health-risk reduction program. *Community College Journal of Research and Practice,* 36**,** 821-825.

Duvendack, M. and Palmer-Jones, R., 2011.High noon for microfinance impact evaluations:re-investigating the evidence from Bangladesh. Working Paper 27, DEV Working Paper Series.Norwich: The School of International Development, University of East Anglia.

Elliott, J. C., Carey, K. B. & Vanable, P. A. 2014. A preliminary evaluation of a web-based intervention for college marijuana use. *Psychology of Addictive Behaviors,* 28**,** 288.

European Monitoring Centre for Drugs and Drug Addiction 2011. 2011 Annual report on the state of the drug problem in Europe. *European Drug Report.* Lisbon.

Eysenbach, G. 2005. The Law of Attrition. *Journal of Medical Internet Research,* 7**,** e11.

Ford, J. A. & Arrastia, M. C. 2008. Pill-poppers and dopers: A comparison of non-medical prescription drug use and illicit/street drug use among college students. *Addictive behaviors,* 33**,** 934-941.

Forlizzi, J. and Battarbee, K., 2004, August. Understanding experience in interactive systems. In Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques (pp. 261-268). ACM.

Glasgow, R.E., Phillips, S.M. and Sanchez, M.A., 2014. Implementation science approaches for integrating eHealth research into practice and policy. International journal of medical informatics, 83, pp.e1-e11.

Gould, J.D., 2000. How to design usable systems. Readings in Human Computer Interaction: Towards the Year, pp.93-121.

Guertler, D., Vandelanotte, C., Kirwan, M. and Duncan, M.J., 2015. Engagement and nonusage attrition with a free physical activity promotion program: the case of 10,000 steps Australia. Journal of medical Internet research, 17.

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J. & Cajander, Å. 2003. Key principles for user-centred systems design. *Behaviour and Information Technology,* 22**,** 397-409.

Gulliver, A., Farrer, L., Chan, J. K., Tait, R. J., Bennett, K., Calear, A. L. & Griffiths, K. M. 2015. Technology-based interventions for tobacco and other drug use in university and college students: a systematic review and meta-analysis. *Addiction science & clinical practice,* 10**,** 5.

Hassenzahl, M., Diefenbach, S. & Göritz, A. 2010. Needs, affect, and interactive products–Facets of user experience. *Interacting with computers,* 22**,** 353-362.

Helmer, S. M., Muellmann, S., Zeeb, H. & Pischke, C. R. 2016. Development and evaluation of the efficacy of a web-based 'social norms'-intervention for the prevention and reduction of substance use in a cluster-controlled trial conducted at eight German universities. *BMC public health,* 16**,** 252.

Hser, Y.-I., Grella, C. E., Hubbard, R. L., Hsieh, S.-C., Fletcher, B. W., Brown, B. S. & Anglin, M. D. 2001. An evaluation of drug treatments for adolescents in 4 US cities. *Archives of General Psychiatry,* 58**,** 689-695.

Johnston, LD.; O'Malley, PM.; Bachman, JG. & Schulenberg, JE. 2005. Monitoring the Future: National Survey Results on Drug Use, 1975–2004, Vol. 1, NIH Publication No. 05–5727. Bethesda, MD: National Institute on Drug Abuse.

Kelders, S. M., Kok, R. N., Ossebaard, H. C. & Van Gemert-Pijnen, J. E. W. C. 2012. Persuasive System Design Does Matter: A Systematic Review of Adherence to Web-Based Interventions. *Journal of Medical Internet Research,* 14**,** e152.

Kelders, S. M., Oinas-Kukkonen, H., Oörni, A. & Van Gemert-Pijnen, J. E. 2016. Health Behavior Change Support Systems as a research discipline; A viewpoint. *International journal of medical informatics,* 96**,** 3-10.

Kellermann, A. & Jones, S. 2013. What It Will Take To Achieve The As-Yet-Unfulfilled Promises Of Health Information Technology. *Health Affairs,* 32**,** 63-68.

Lee, C. M., Neighbors, C., Kilmer, J. R. & Larimer, M. E. 2010. A brief, web-based personalized feedback selective intervention for college student marijuana use: a randomized clinical trial. *Psychology of addictive behaviors,* 24**,** 265.

Mallett, R., Hagen-Zanker, J., Slater, R. and Duvendack, M., 2012. The benefits and challenges of using systematic reviews in international development research. Journal of development effectiveness, 4, 445-455.

May, C.R., Johnson, M. and Finch, T., 2016. Implementation, context and complexity. Implementation Science, 11, 141.

McCarthy, J. & Wright, P. 2004. Technology as experience. *interactions,* 11**,** 42-43.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. & Group, P. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine,* 6**,** e1000097.

Morrison, L.G., Yardley, L., Powell, J. and Michie, S., 2012. What design features are used in effective e-health interventions? A review using techniques from Critical Interpretive Synthesis. Telemedicine and e-Health, 18, 137-144.

Murray, E., White, I.R., Varagunam, M., Godfrey, C., Khadjesari, Z. and McCambridge, J., 2013. Attrition revisited: adherence and retention in a web-based alcohol trial. Journal of medical Internet research, 15.

Newcomb, M. D. & Bentler, P. M. 1988. Impact of adolescent drug use and social support on problems of young adults: A longitudinal study. *Journal of abnormal psychology,* 97**,** 64.

Nielsen, J., 1994. Usability engineering. Elsevier.

Norman, D. A. 1986. Cognitive engineering. *User centered system design,* 31**,** 61.

O'Brien, H. L. & Toms, E. G. 2008. What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the Association for Information Science and Technology,* 59**,** 938-955.

Orji, R. & Moffatt, K. 2016. Persuasive technology for health and wellness: State-of-the-art and emerging trends. *Health informatics journal***,** 1460458216650979.

Palfai, T. P., Saitz, R., Winter, M., Brown, T. A., Kypri, K., Goodness, T. M., O'brien, L. M. & Lu, J. 2014. Web-based screening and brief intervention for student marijuana use in a university health center: pilot study to examine the implementation of eCHECKUP TO GO in different contexts. *Addictive behaviors,* 39**,** 1346-1352.

Perski, O., Blandford, A., West, R. and Michie, S., 2017. Conceptualising engagement with digital behaviour change interventions: a systematic review using principles from critical interpretive synthesis. Translational behavioral medicine, 7, 254-267.

Pischke, C. R., Zeeb, H., Van Hal, G., Vriesacker, B., Mcalaney, J., Bewick, B. M., Akvardar, Y., Guillén-Grima, F., Orosova, O. & Salonna, F. 2012. A feasibility trial to examine the social norms approach for the prevention and reduction of licit and illicit drug use in European University and college students. *BMC Public health,* 12**,** 882.

Pucillo, F. and Cascini, G., 2014. A framework for user experience, needs and affordances. Design Studies, 35(2), pp.160-179.

Rogers, Y., 2011. Interaction design gone wild: striving for wild theory. Interactions, 18(4), pp.58-62.

Ryan, C., Bergin, M. & Wells, J. S. 2017. Theoretical Perspectives of Adherence to Web-Based Interventions: a Scoping Review. *International Journal of Behavioral Medicine*.

Schnall, R., Rojas, M., Bakken, S., Brown, W., Carballo-Dieguez, A., Carry, M., Gelaude, D., Mosley, J.P. and Travers, J., 2016. A user-centered model for designing consumer mobile health (mHealth) applications (apps). *Journal of biomedical informatics*, 60, 243-251.

Sheldon, K. M., Elliot, A. J., Kim, Y., & Kasser, T. 2001. What is satisfying about satisfying events? Testing 10 candidate psychological needs. Journal of personality and social psychology, 80(2), 325.

Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M. 2015. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. JMIR mHealth and uHealth, 3(1).

Sussman, S. & Arnett, J. J. 2014. Emerging adulthood: developmental period facilitative of the addictions. *Evaluation & the health professions,* 37**,** 147-155.

Taki, S., Lymer, S., Russell, C.G., Campbell, K., Laws, R., Ong, K.L., Elliott, R. and Denney-Wilson, E., 2017. Assessing user engagement of an mHealth intervention: development and implementation of the growing healthy app engagement index. JMIR mHealth and uHealth, 5.

Thomas, M. ed., 2011. Deconstructing digital natives: Young people, technology, and the new literacies. Taylor & Francis.

Tomlinson, M., Rotheram-Borus, M.J., Swartz, L. and Tsai, A.C., 2013. Scaling up mHealth: where is the evidence?. PLoS medicine, 10(2), p.e1001382.

Tønnesen, H., Ståhlbrandt, H. and Pedersen, B., 2013. Web-based brief interventions for young adolescent alcohol and drug abusers–a systematic review. CLINHP, 3(3), pp.75-82.

Toye, F., Seers, K., Allcock, N., Briggs, M., Carr, E., & Barker, K. 2014. Meta-ethnography 25 years on: Challenges and insights for synthesising a large number of qualitative studies. BMC Medical Research Methodology, 14, 80–80.

Van Gemert-Pijnen, J. E., Nijland, N., Van Limburg, M., Ossebaard, H. C., Kelders, S. M., Eysenbach, G. & Seydel, E. R. 2011. A Holistic Framework to Improve the Uptake and Impact of eHealth Technologies. *J Med Internet Res*, 13**,** e111.

Whitton, A.E., Proudfoot, J., Clarke, J., Birch, M.R., Parker, G., Manicavasagar, V. and Hadzi-Pavlovic, D., 2015. Breaking open the black box: isolating the most potent features of a web and mobile phone-based intervention for depression, anxiety, and stress. JMIR mental health, 2(1).

Wright, P., & McCarthy, J. 2010. Experience-centered design: designers, users, and communities in dialogue. Synthesis Lectures on Human-Centered Informatics, 3, 1-123.

Yardley, L., Spring, B.J., Riper, H., Morrison, L.G., Crane, D.H., Curtis, K., Merchant, G.C., Naughton, F. and Blandford, A., 2016. Understanding and promoting effective engagement with digital behavior change interventions. American journal of preventive medicine, 51, 833-842.