Combining e-mental health intervention development with human computer interaction (HCI) design to enhance technology-facilitated recovery for people with depression and/or anxiety conditions

An integrative literature review

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Complete Title: Combining e-mental health intervention development with human computer interaction (HCI) design to enhance technology-facilitated recovery for people with depression and/or anxiety conditions: An integrative literature review

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Abstract

Computer scientists contend that understanding human computer interaction (HCI) is an important factor in developing successful computer user experiences. Mental health professionals across a range of disciplines are increasingly developing and implementing internet-based treatments for people with a variety of mental health conditions. Many therapeutic and economic benefits are associated with technology-enabled treatments for a range of mental health disorders. Despite this, the role of HCI and associated design elements remains poorly understood in regard to the impact on patient safety, effectiveness and to adherence of treatment for computer users who engage with e-mental health interventions.

An integrative literature review was conducted to investigate how adequately HCI and user-centred design is incorporated in the development of e-mental health interventions for depression and anxiety, and subsequently reported in literature to inform evidence-based practice. The PRISMA model was used to locate, select and include 30 relevant articles.

The main finding of this review is that internet-based e-mental health interventions are routinely implemented without sufficiently describing the relevant HCI design features applied. This is a limitation that in turn jeopardizes the assessment validity of e-mental interventions generally, leaving those who administer the interventions with incomplete evidence to support the safe, reliable, dependable, credible, and trustworthy implementation of the interventions.

The recommendation arising from this review is that human computer interaction should be carefully considered when mental health nurses and other practitioners adopt e-mental health interventions for therapeutic purposes to
assure the quality and safety of e-mental health interventions on offer to patients.

Introduction

Online digital interventions and mobile applications for support, collaborative care and treatment are utilized increasingly and successfully for mental health advantages (Schueller et al., 2017, Feather et al., 2016, Andersson et al., 2014). A wide range of information is conveniently available to the general public and can be accessed using a variety of digital products and platforms (Barlow et al., 2005, Zhao et al., 2017, Huguet et al., 2016). It is now possible for people to learn about their own disorder and commence self-directed lifestyle changes to enhance and strengthen mental and emotional resilience, health promotion and prevention strategies and engage in therapeutic exercises without directly consulting a health care professional in a face-to-face setting (Wilson, 2017). It is increasingly necessary for mental health clinicians, including nurses, to be able to critically analyse the benefits and limitations of mental health digital products and platforms so that they are able to engage helpfully with their patients about the best quality approaches available to them. To optimize such an approach, it is relevant to carefully consider how people interact with digitally provided treatment programs, and to understand the particular barriers people with mental disorders encounter within the digital setting; and, what, if any, benefits emerge from utilizing digital media for mental health intervention purposes. This integrative literature review draws together what is already known about the topic and specifically describes the relevant themes in the published literature over the last ten years, regarding human computer interaction (HCI) in the e-mental health research context.

Human Computer Interaction (HCI) refers to the scientific field of interaction between humans and computing technology. HCI science recognizes the importance of understanding the centrality of the user interaction with the investigated system within a particular context or setting and with a goal of building a computer system that works in an intended way (Kobak et al., 2015).
This review examines two specific mental health conditions: depression and anxiety disorders, because internationally, these conditions represent the most common mental health disorders in the world. All gains in refining the usability and interactive components of computer-based treatment are likely to assist people to adhere to a full treatment (dose) program and will promote early recovery, or, remediation of distressing symptoms (Hilgart et al., 2012). The extent to which HCI will influence the successful uptake and receptiveness to adherence of treatment for people with specific mental health conditions is largely unknown at this time. Therefore is it necessary to consider how patients behave as a user of the computer system and how this influences their successful and or unsuccessful interaction with the program, and by extension, with the treatment itself.

**Aims**

Specifically, the aim of this integrative literature review is to identify the human computer interactions that have been recognized as beneficial within literature published about online treatment programs for people with depression and anxiety disorders. The main question for this investigation is: How can human computer interaction facilitate a positive experience for people with depression and anxiety?

**Methods**

An integrative literature review was selected because the investigators were interested to understand a wide range of human experiences about human computer interactions, and it was considered that both quantitative and qualitative sources could usefully answer the question under investigation. Whitmore and Knafl’s (2005) model for integrative review of the literature was followed to guide the review methodology (Whitmore & Knafl, 2005).

This integrative review (Whitmore & Knafl, 2005) aims to determine and prioritize the components of HCI and computer design models that are central when designing treatment programs for people with anxiety and depression.
within a framework (Morrison et al., 2012). The review was methodologically designed using the PRISMA technique (Moher D, 2009).

- Insert table 1 here –

**Inclusion criteria**

All relevant and available peer-reviewed publications were identified using and/or MeSH keywords search (see Table 1) and collected from CINAHL, Medline, EMBASE, PsycInfo databases. In particular, the intention of this review was to identify computer design components described in publications between 2007 and May 2017. For inclusion, the articles related to the following aspects: online therapeutic psychoeducational interventions specifically for people with anxiety and depression conditions; online therapeutic interventions that include design methods and principles; interactive elements including visual, textual or auditory components, and the impact these factors have on the clinical effectiveness, adherence or other clinical aspects.

**Exclusion criteria**

Online therapeutic intervention in this review is defined as any web-based interventions with a self-help element that requires users to work their way through a series of computer-based or online information. Telepsychiatric counselling, such as videoconferencing or text-based counselling where treatment is based on person-to-person interaction rather than HCI was excluded. Social networks and other webpages or tools that were not explicitly designed for the purpose of treatment were also excluded. Additionally, studies of online interventions with no mention of design considerations, or with a non-specific view on usability were excluded from the review. Self-reported post-treatment usability scales were not considered sufficient to provide specific design reflections because they were limited to a general view about users overall satisfaction and comprehension of usability and do not adequately discriminate the unique design components, and so these were excluded from the review.
One study that focused on special design implication for older adults was excluded because it focused on specific design features based on their assumption that elderly people are digitally illiterate and that they are not sufficiently familiar with the use of computers in general. While this may have been the case for the sample in that study, we don’t concur that elderly people are generally insufficiently familiar with computers, and so this contrary article was discarded. Furthermore, interventions targeting relatives, families and clinicians were excluded because they did not meet the inclusion criteria of experiencing a first-hand mental health problem or disorder.

The remaining 42 articles were read thoroughly to identify specific HCI and design components represented in the article, and if they were assessed to be beneficial, necessary or relevant to directly answering the review question under investigation, they were retained. Following review of full-length articles and in consultation with an experienced researcher, it was decided to exclude a further 12 studies because they did not meet the inclusion criteria (See table 2). In total, 30 articles were included (see table 3) in the review and their contents were analysed using a conceptual design framework (Morrison et al., 2012).

[Insert table 2 here ]-

[Insert Table 3 here]

**Human Computer Interaction design in e-mental health**

Usability testing is frequently undertaken to pilot the acceptability and feasibility of a computer-based program. People with mental health disorders are often excluded from standard usability testing of online health care interventions, because of specific concerns about cognitive difficulties likely to be experienced within this group (Morrison et al., 2012). This is a paradox according to several different approaches in HCI. The science of HCI suggests that it is pivotal to consider these cognitive difficulties specifically using the theoretical concept of Universal Design (UD) (Mace, 2017). UD refers to the concept of designing interactions with the express purpose to both aesthetically please and to achieve usability to the greatest extent possible for everyone, regardless of age,
ability or status in life. One approach that is well matched as a theoretical framework applied to the e-mental health context is to achieve universal design using a human-centred design (HCD) approach (Kurosu, 2011). Therefore the framework by Morrison et al. (2012), which is derived from a review that excluded studies of mental health disorders, has been selected.

The HCD approach requires that the needs of users, and the context in which users interact with the system are well defined and that the actual users are included in the testing phase to identify common interaction patterns that may be extracted from the user’s needs (Kurosu, 2011). This requires an early identification of the therapeutic purpose of the program if such information is to inform the design process. The identified needs of users at this stage is valuable information which can be harnessed to create a purpose-driven strategy for the development of the computer-based program, including the navigation, content, and colour selections (Hesse and Shneiderman, 2007).

**Results**

**Design principles**
A prominent theme across the reviewed literature is the common aim to build user-friendly and easy-to-use systems. While the overall design goal to support the strategy of the program is frequently apparent, the literature fails to describe how this is achieved. Some authors describe more detailed principles (see Table 4). However, identifying where and when a lack of detail is provided by authors and program developers is particularly relevant because some design principles are considered specifically beneficial for enhancing mental health outcomes (Doherty et al., 2010). Regardless of the type of design principles utilized to guide the design architecture, it is essential to investigate how these principles are applied in the design of the e-mental health applications. It is a particular concern that in this review of the literature, none of the papers included have managed to adequately describe how their design principles are applied in the context of an e-mental health intervention. This is significant because there is no way of validating or critiquing the methodological
approaches used to ensure that a reliable, trustworthy and dependable approach has been used to establish the design infrastructure, and this remains a vulnerable component in the production of suitable evidence to support best e-mental health practice. The essential building blocks of producing a reliable and safe e-mental health intervention require a deeper level of critique so that quality interventions can be developed and implemented in the future.

- Insert table 4 here -

Discussion
Components and Layers of design
This review has classified the components contained in the reviewed articles using the (Morrison et al., 2012) conceptual framework for design features with a focus on the four interactive features hypothesized to mediate intervention outcome: social context and support; contacts with the intervention; tailoring; and, self-management (Morrison et al., 2012). In addition to the framework this review also examines components classified as layout and instructional design constituents (Mayer, 2014) (see table 5).

- Insert table 5 here -

The layout constitutes the gateway interface for the purpose of the intervention, and thus, it is especially important that a clear design is evident because this layer is instrumental in engendering trust for the user (Fogg et al., 2001). The layout assists the target audience of people to focus on the most relevant pieces of information, promotes concentration, and enhances recall so that what is read by the user is more likely to be remembered. Ensuring that the layout is designed with a clear strategy is a very well established concept within HCI and design theories (Bol et al., 2013, Bol et al., 2015, Meppelink et al., 2015, Mayer, 2014).
Renton et al. (2014) reviewed 32 programs discovered through a Web search that targeted depression and found that most programs were multimodal, with seven delivered solely by text (Renton et al., 2014). They concluded that because cognitive difficulties were common in their target group, that a recommendation to focus on text sizing, multimodal delivery and programming specific to cognitively impairment was particularly important in communicating effectively. This is in agreement with the HCI design theory of instructional design from Mayer (2014) which states that people learn more effectively and comprehensively using multimedia when compared with singular media.

Layout (Colours and images)
Six articles in the review described the importance of colour and image as layout design components in usability testing of web-based mental health interventions. Bae et al., (2009) conducted a need assessment in Korea, where they investigated different types of layout components. Their pilot testing of a health information system for patients about depression symptom management revealed a need to modify the system to use a larger text font size and to change the colour of the text from black to dark grey. Tiburcio et al. (2016) conducted usability testing of web-based self-help programs in Mexico among a sample of people with the comorbid conditions of substance misuse and depression, and discovered that those users preferred additional images and colours as elements to promote usability. Danaher et al., (2012) conducted focus group interviews to complement usability testing of a web-based intervention for symptoms of postpartum depression in USA and Australia, and their findings correspond with Tiburcio et al., (2016) findings with a preference for images and colours to enhance user experience.

Usability testing of an iCBT (internet-based cognitive behavioural therapy) program to reduce symptoms of emotional distress by Currie et al. (2010) in Canada aligned with Bae et al., (2009), Tiburcio et al., (2016) and Danaher et al., (2012) further emphasizing that aesthetic appearances of the text were
important layout issues Currie et al. (2010) further concluded that their findings are consistent with the literature on good web design generally. However, one limitation on their findings was that their program was tested on a convenience sample of college students instead of an end user target group of people with a depression or anxiety disorder.

Wozney et al., (2015), in another qualitative study where young people were interviewed regarding usability testing of a iCBT-program designed for adolescents with anxiety in Canada, found that young people preferred bullet lists and visual cues for key concepts in preference to large quantities of text. They highlighted the importance of the use of appealing colours, and the problems of distractions derived from typographical errors, layout flaws and poor aesthetics in general.

Kelders et al., (2013) Dutch usability testing study investigated the appropriateness of colours, pictures, fonts, buttons, headers and other layout components. However, in this study, interviews were conducted with health experts on the conditions experienced by the target group, rather than the target group itself. This could be seen as a significant limitation in assessment of design according HCD principles, in this case though, Kelders et al., (2013) concluded that the target group itself was more positive about usability than the expert group. Additionally, Kelders et al., (2013) argued that the experts could adequately represent the target group because of their discreet knowledge of the clinical aspects of the topic area.

In summary, the synthesis of the findings about layout features from the articles reviewed showed that attention to the layout layer of design should be tailored to specific user target groups, with variation occurring across user groups. Specific tailored consideration of images, colours, text quantity, font size and colour should corresponds with what users find appealing because this is likely to be important in regard to the successful engagement, adherence and trust of users. This is relevant when applied to the e-mental health intervention context,
because ensuring the surface layer design is sound will provide an important foundation for the effective engagement of the user with the intended intervention and its intended duration.

Navigation and instruction

Essential to any program is that the users know how to use the program most effectively. Independently navigating pages, completing online exercises and entering personal information into diary tools are all examples frequently used in e-mental health interventions. Among the articles reviewed, seven stated the need for improved instructions to users to enhance usability and promote treatment adherence (Tiburcio et al., 2016, Wozney et al., 2015, Kelders et al., 2013, Ho et al., 2016, Danaher et al., 2012, Davidson et al., 2014, Currie et al., 2010).

Tiburcio et al. (2016:11) interviewed people with drug abuse problems in Mexico and found that the users required “more concrete instructions”. Wozney and colleagues’ (2015) interviewed young people in Canada and their results identified the need for an adaption to their implementation strategy including additions of a virtual guided tour together with more explicit instructions such as extra internal links on their webpage to enhance successful user navigation (Wozney et al., 2015). Danaher (2014) conducted usability testing with users from USA and Australia and recommended use of more context-sensitive instructions. Davidson et al., (2014:80) reported in their usability testing of adolescents from USA that “75 % [of the participants] had one or more instances where they were confused about the navigation or text”.

Based on our synthesis drawn from these authors it can be extrapolated that where the design is not self-explicit the designers are required to guide users to a greater extent. In this context, the application of the principle of learnability is highly relevant to make it easier for users to navigate the system, however none of the papers included in this review adequately described how learnability principles were applied in their navigation strategies. This is extremely
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Kelders et al. (2013) conducted a Dutch usability testing study where clinical staff confirmed that reminders could enhance effectiveness of a web-based ACT-intervention for prevention of depression. Zhao et al. (2017) conducted a systematic review of 55 studies of psychoeducational interventions for depression and found that reminders were identified as an important and effective content component. Ho et al. (2016) found in their American log data analysis that it was also effective to send reminders to users, that have not logged in for a long time to reinvigorate their motivation to participate in the interventions (Ho et al., 2016). Kobak et al. (2015) investigated the use of text-messages in between face-to-face therapy sessions as an encouragement to continue therapy adherence for adolescents with depression in America and found that the text messages improve adherence to treatment in a blended care strategy.

The articles reviewed indicated that support structures such as a reminder service was a useful design component. However, a limitation of the articles reviewed is the lack of focus on the specific content, design principles, delivery methods or visual appearances of their messages. Without detailed information about these aspects it is not possible to evaluate the design principles used explicitly, but it can be extrapolated that these types of messages have the potential to reach into the everyday life of users and act to remind them to consistently participate in planned online treatments.

Contacts with the intervention
Morrison et al. (2012) hypothesize that contacts containing behavioural change techniques might be more effective than simple reminders. Several review authors have indicated that supportive text and email messages can be used to strengthen the quality of adherence to intervention programs and this aligns
with the Morrison et al. (2012) framework. Van Gemert-Pijnen et al. (2014) analysed log data from the same intervention investigating a sms-coach as a randomized persuasive feature and found that persuasive features peak in a certain part of the program and thereby suggest that persuasive features can have higher implication within specific intervals of the treatment protocols.

Additionally, Tiburcio et al. (2016) showed in their Mexican-based description of web-based self-help for substance misuse and depression, that when a task is finished, users gain from personally engaging with reflective feedback on the task. The need for user feedback is raised as a factor in 11 of 30 articles reviewed (Miloff et al., 2015, Kemmeren et al., 2016, Wozney et al., 2015, Mohr et al., 2010, Zhao et al., 2017, Kelders et al., 2013, Van Gemert-Pijnen et al., 2014, Lara et al., 2014, Tiburcio et al., 2016, Brown et al., 2016, Cartreine et al., 2012). Brown et al. (2016) conducted a systematic literature review of RCT’s investigating gaming features in web-based interventions for common mental disorders. One of the most prominent findings was that the effectiveness of gaming features benefit from feedback within the interventions. The overall need for feedback and contact with the intervention is apparent, but the content and design was not systematically investigated.

Self-management

Elements of self-management are a central to most treatments included in the articles reviewed. Self-management components included: activity planning, activity tracking, self-monitoring and diaries. The hypothesis from the framework is that self-management components that include behavioural change techniques are more effective than those that do not (Morrison et al., 2012). Self-reporting or self-monitoring was found to be effective strategy and was used frequently in the studies included in this integrative review. Renton et al. (2014) conducted a review of web programs for treatment of depression and found that almost all of the programs included the self-evaluation task of mood tracking.
Whitton et al. (2015) log data analysis for users of a web and mobile based treatment for depression, anxiety and stress showed that daily or weekly symptom tracking was one of the most frequently used components. Richards et al. (2016) results of a self-reported online questionnaire study for the online treatment of depression found that the mood monitoring rating tool was a favourite tool among users. Kok et al., (2014) showed log data of users of mobile CBT for depression also found popular use of mood monitors. Mohr et al., (2010) feasibility study used self-monitoring as a persuasive feature (Mohr et al., 2010) in treatment of depression, and Kelders et al., (2013) usability testing of web-based ACT-interventions for depression agreed in the use of self-monitoring tools and design enhancements. Kobak et al., (2015) pilot study proposed that in-session use of tablets/smart book technology and text messaging between face-to-face sessions benefited from the use of mood records through text messages. Lauritsen et al. (2017) conducted a study of a self-monitoring system where the goal and strategy of the system was self-monitoring and found that alarms connected to self-rating could improve self-management.

Danaher et al. (2012) conducted an usability testing study including the utilization of design to enhance the function of the self-monitoring and concluded that the tracking tool requires a simple interface along with clear instructions for users to benefit adequately. In all other cases, self-monitoring is a functional specification of the program. A limitation across all the other articles reviewed was that there was no information about the visualization of the self-monitoring and so it is not possible to adequately replicate the beneficial components of visualization because they are not adequately described.

Tailoring

Many of the treatments described in the articles reviewed were set in the context of a desire for them to be interesting, comfortable, engaging, convenient, relevant, useful and personalized. For this to be achieved it is a necessary design feature to tailor the content to the user’s needs and preferences. Tailoring is usually achieved by the setting realistic goals, selecting
customizable characters, creating game elements, and choosing desirable and accessible forms of delivery. The hypothesis of Morrison’s framework is that tailoring on multiple variables is more effective than tailoring on single variable (Morrison et al., 2012). Tiburcio et al. (2016) reports a need for the ability to modify weekly goals throughout the time span of the intended intervention. Miloff et al. (2015) described how tailoring can be used for users to select or change their goals throughout the time span of their intervention and both Danaher et al. (2012) and Kobak et al. (2015) described the need for personalized goals within the intervention. It can be seen that tailoring is an important aspect for enhancing the user experience with the intervention, however, despite this importance, none of the articles reviewed elaborated on the methods they used to create a personalized experience for the user. This is a major limitation in the reporting of design feature generally across all of the reviewed articles. Therefore, it is not possible to adequately evaluate the rigor and trustworthiness of the tailoring aspects discussed in the articles reviewed.

Limitations
Related to the quantity of characteristics of HCI and Interaction Design, there are several design issues that have not been addressed in the analysis in this integrative review. As a consequence of the selected framework this review did not distinguish between mobile and non-mobile technologies and included both types. Mobile technology is integrated into the daily life of users differently to that of the computer; for example, it often has touchscreen, smaller screens, and is used frequently throughout the 24-hour period. The need to be able to access the program from a mobile device is explicitly mentioned in several of the examined articles (Kok, 2014, Lauritsen et al., 2017, Miloff et al., 2015, Pham et al., 2016, Wilansky et al., 2016, Zhao et al., 2017).

Another element that was omitted with the selected framework is the element of time. It is possible to design a program for short interactions, or for longer duration sessions. This could be relevant when applied to motivational therapies and for the promotion of adherence.
The findings of this review revealed that notifications and feedback from programs are a frequently used and recommended feature, however, based on the information contained in the articles we reviewed, it was not possible to determine whether the notifications were provided by humans, automation or artificial intelligence. This could have an impact on trust and, in turn, effectiveness of the interventions that were examined. Similarly, expert or peer support was not examined because it has been discussed widely in the literature elsewhere, and was beyond the scope of the strict human computer interface interaction adopted for this review.

Cultural differences related to design were not considered due to the selection of the framework, even though some of the examined papers explicitly mention this as an important point (Bae et al., 2009, Cheek et al., 2015, Currie et al., 2010), it was considered to lie beyond the scope of this review.

**Recommendations**

The findings of this integrated literature review clearly support the notion that e-mental health interventions are able to accommodate and facilitate an avenue for people to interact with the treatment on their own, in the form of self-help, or as guided treatment. Without the constraint of face-to-face interaction with a mental health clinician, people are supported to learn about their own disorder and commence self-directed lifestyle changes to enhance and strengthen mental and emotional resilience, health promotion and prevention strategies, and to engage in specific interventions designed to reduce their personal experience of distress or discomfort (Wilson, 2017). It is evident from our review that while a great deal of emphasis is placed on the internet based program, we still know very little about the design infrastructure of all of the e-mental health interventions available. Given the vulnerability of the target population and the dosage of treatment delivered in an internet-based intervention it is critically important that these programs can be critically assessed for safe and effective delivery of the treatment. This is pivotal to good intervention delivery practice
whereby the implementations of health interventions are adequately assessed for benefits, and harms are avoided and/or mitigated. It is our recommendation that future publication of e-mental health interventions should include adequately described design principles used within them, such that mental health nurses and other clinicians can critically analyse the suitability of these interventions for specific populations of patients. A suitable framework to guide the report of these aspects can be extrapolated from Morrison et al. (2012) using their five categories (see Table 3) to highlight how each has been addressed in the new report. In this way mental health intervention development teams, prescribers and administering clinicians can be assured that the e-mental health product is sufficiently reliable, dependable, credible and trustworthy for safe and beneficial human use.

It is beneficial for the future development of effective, interesting, safe and engaging e-mental health intervention programs, that full consideration is given to the design aspects of the human computer interactions. This review was successful in identifying 30 articles whereby HCIs were considered in relation to e-mental health interventions. However, the paucity of studies overall that have explicity examined features of design components suggest that a significant knowledge gap exists in regard to understanding the most beneficial design aspects for use in web-based treatment of depression and anxiety; and, how the design principles are best applied. To rectify this, it is necessary to include computer scientists, interaction designers, mental health clinicians and professionals (such as mental health nurses, psychologists, medical doctors and public health specialists), and users/patients in the innovation, at research and development stages to provide a comprehensive knowledge base to further develop safe, reliable, trustworthy, dependable and credible e-mental health intervention in the future.

**Conclusion**

The findings of our literature review revealed that HCI and design is scantily described within literature about e-mental health interventions. This is particularly concerning because without detailed HCI and design information, it
is impossible to replicate an e-mental health intervention study and this has ramifications for validating the effectiveness, quality and patient safety of the interventions developed and proposed for the digital treatment of depression and anxiety. This finding renders caution for mental health clinicians and suggests that clinicians who include e-mental health interventions in care plans for patients with depression and anxiety should do so with full due diligence to ensure that they have selected safe interventions where beneficial outcomes are achieved and harms are avoided. This review identified 30 relevant articles that were able to contribute to describing how HCI’s facilitate a positive experience for people with depression and anxiety. Most prominent were 11 descriptions of usability tests, five metasynthesis studies and reviews; four examinations of log data; and, two surveys. Additionally, there were three protocols and a further five other types of studies all attempting to determine the needs and actions of the users in relation to e mental health interventions.

While some design principles were identified in most of articles, these were not comprehensively described and the application of these principles to the e-mental health intervention delivery was less considered. This review of the literature showed that authors superficially attended to the different layers of design, and design components set out by Morrison et al., (2012). The intention for the internet-based intervention is permanent; however, the use of social context and support, contacts analytics with the intervention, tailoring, self-management, and layout strategies differ across the studies we reviewed. From the descriptions available we were able to ascertain that reminder tools are useful as a support strategy for users and that feedback is an important contact with the intervention. Self-monitoring elements were frequently included in the e-mental health interventions, but without sufficient elaboration to make informed inferences about HCI and design features most suitable for e-mental health interventions generally. Tailoring was often attempted and demonstrated using goal setting strategies, but again, the specific design elements were not adequately described, and as a result, a replication difficult to achieve. These features might have an implication on clinical effectiveness, and adherence to,
the treatment and therefore need to be extremely well described so that replication of each study is possible (Morrison et al., 2012).

Consideration of layout features such as images, text quantity, font size and colour/s should correspond with what the actual users find appealing and useful because this is likely to be important in regard to the successful engagement, adherence and trust towards the program.

Likewise, there were some common limitations in regard to navigation and the inclusion of instructions within the programs reviewed. Some studies in the review conducted usability tests, with interviews and surveys to providing data about the users expectations, including their needs and desires for future use. However, not all of the usability tests in this study were done with the relevant target group/s, and so, are not capable of contributing to a comprehensive knowledge about specific design components relevant for the precise target group. In contrast, the log data studies provide accurate information about the actual use and non-use of actual components, and these are a valuable source of information capable of revealing if users actually behave in the way anticipated by the software designers and clinical development teams.

In combination, these analytics provide wide-ranging feedback to developers and clinicians about user/ patient engagement with and use of specific components of e-mental health interventions. It is possible to use this information to further enhance the user experience in future version updates and iterations such that the needs and of the user are more closely adhered too, and the engagement experience improved where this is needed. HCI and HCD have the capacity to facilitate and enhance a positive user experience by designing core features of interaction, but future research needs to be conducted to better describe how this is likely to be achieved in the e-mental health intervention.

Clinical implication: Mental health clinicians, such as mental health nurses, and psychologists, should assure themselves that they are prescribing and administering e-mental health interventions to the right patients, treating the right conditions, with the right dose, using the right format/route/platform/device, and underpinned by the right evidence base. Attention to HCI design is an
essential component for ensuring the safe administration and navigation of e-mental health interventions.

Interdisciplinary implication: An interdisciplinary approach for the development and implementation of e-mental health interventions requires a close collaboration between mental health professionals and computing scientists to ensure safe e-mental health interventions are developed and tailored for specific conditions, patient types, adherence regimes and with the most appropriate multimodal combinations, and matched to user experiences. An interdisciplinary collaboration of this type will improve the ways that information technologists can create a finely targeted user experience for internet-based e-mental health treatment programs and in doing so assist with rates of adherence to treatment programs, therapeutic outcomes and reinforcing the recovery process.

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TOPOLOVEC-VRANIC, J. 2014. Web-based intervention programs for depression: a

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Table 1: Keywords including MeSH terms used in literature search strategy
"depressive disorder" OR "depressive" AND "disorder" OR "depressive disorder" OR "depression" OR "anxiety" OR "affective" AND "e-mental" OR "digital" OR "web-based" OR "internet" OR "telepsychiatry" AND "usability" OR "user' AND "experience" OR "interaction" OR "internet intervention" AND "usability" OR "user experience" OR

Table 2: Study identification and selection

<table>
<thead>
<tr>
<th>Records identified through database searching (n = 1275)</th>
<th>Additional records identified through other sources (n = 3)</th>
<th>Records excluded: (n=939) because of diverse disorders (e.g. cancer or diabetes), studies of general information portals or studies of non-digital</th>
</tr>
</thead>
</table>

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Abstracts screened (n = 136)

Full-text articles assessed for eligibility (n = 42)

Studies included in qualitative synthesis (n = 30)

Abstracts excluded: (n=94) because of diverse disorders (e.g. cancer or diabetes), studies of general information portals or studies of non-digital

Full-text articles excluded, as studies that did not mention any specific design considerations (n = 12)

**Table 3: Overview of reviewed articles**

<table>
<thead>
<tr>
<th>Protocol Type</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Protocols</td>
<td>(Wilansky et al., 2016, Miloff et al., 2015, Kemmeren et al., 2016)</td>
</tr>
<tr>
<td>5 Meta-synthesis or reviews</td>
<td>(Knowles et al., 2014) (Cheek et al., 2015, Zhao et al., 2017, Renton et al., 2014, Brown et al., 2016)</td>
</tr>
<tr>
<td>11 Description and qualitative analysis of development and usability tests, interviews, focus group interviews</td>
<td>(Tiburcio et al., 2016, Logsdon et al., 2013, Wozney et al., 2015, Kelders et al., 2013, Ho et al., 2016, Bae et al., 2009, Danaher et al., 2012, Cartreine et al., 2012, Davidson et al., 2014, Currie et al., 2010, Lauritsen et al., 2017)</td>
</tr>
<tr>
<td>2 Presentation of surveys</td>
<td>(Bickmore et al., 2010) (Richards et al., 2016)</td>
</tr>
<tr>
<td>4 studies of log data</td>
<td>(Whitton et al., 2015, Kok, 2014, Van Gemert-Pijnen et al., 2014, Lara et al., 2014)</td>
</tr>
<tr>
<td>5 other types of studies</td>
<td>(Bresó, 2016, Rice et al., 2016, Mohr et al., 2010, Pham et al., 2016)</td>
</tr>
<tr>
<td>Main issue or research question/problem</td>
<td>Article type/research design</td>
</tr>
<tr>
<td>----------------------------------------</td>
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</tr>
<tr>
<td>Wilansky [1], 2016, Canada</td>
<td>Homework adherence through mobile tech.</td>
</tr>
<tr>
<td>Knowles [2], 2013, UK</td>
<td>UX in computerised therapy for depression and anxiety</td>
</tr>
<tr>
<td>Tiburcio [3], 2016, Mexico</td>
<td>Web based self-help program for drug abuse and depression</td>
</tr>
<tr>
<td>Study</td>
<td>Setting</td>
</tr>
<tr>
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<tr>
<td>Richards [4], 2016, Ireland</td>
<td>Online supported treatment for depression</td>
</tr>
<tr>
<td>Logsdon [5], 2013, USA</td>
<td>Prototype web site for postpartum depression with adolescent mothers</td>
</tr>
<tr>
<td>Whittton [6], 2015, Australia</td>
<td>Unguided web and mobile phone based treatment for depression, anxiety and stress</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Study</th>
<th>Methodology</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kok [7], 2014, Netherlands</td>
<td>Supported mobile CBT for depression</td>
<td>Log data (quantitative) + interviews (qualitative)</td>
</tr>
<tr>
<td>Cheek [8], 2015, Australia</td>
<td>CBT-game SPARX for adolescent (depression)</td>
<td>Review of 5 studies of Sparx</td>
</tr>
</tbody>
</table>

**Tracking feature**
- n=129
- Relatively high adherence due to ease of use, not too time consuming, and ability to choose between text, videos and assignments.
- Mobile cognitive therapy might be acceptable treatment for most patients, but more studies are needed on different target groups.
- Limits in time measuring log data
- Text-element, look and feel of video recordings, reminder, game-elements, self-monitoring,
- Predictability, Consistency, Customizability

**Important design areas:**
- Gaming, accessibility, working alliance, learning in immersion
- How the element of fun motivates the user is unknown
- Only looked into SPARX - not sure if the model works on other age groups, other cultures etc.
<table>
<thead>
<tr>
<th>Author</th>
<th>App/Protocol</th>
<th>Protocol</th>
<th>N/A</th>
<th>Usefulness/Benefit</th>
<th>Testing</th>
<th>Illustrations</th>
<th>Navigation</th>
<th>Feedback</th>
<th>Social Community</th>
<th>Reminders</th>
<th>Goal-Setting</th>
<th>Game-Elements</th>
<th>Self-Monitoring</th>
<th>Customizability</th>
<th>Familiarity</th>
<th>Generalizability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milhoff [9], 2015, Sweden</td>
<td>App for social anxiety</td>
<td>Protocol</td>
<td>N/A</td>
<td>“Likes” are thought to be useful and beneficial but it is not tested.</td>
<td>Do more A/B testing</td>
<td>Only descriptive no testing</td>
<td>Illustrations, feedback, social community, reminders, goal-setting, game-elements, self-monitoring</td>
<td>Customizability, familiarity, generalizability</td>
<td></td>
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<tr>
<td>Wozney [10], 2015, Canada</td>
<td>CCBT for adolescents with anxiety and mental health prof.</td>
<td>Semi-structured interviews, task completion and survey</td>
<td>5 clinicians, 4 young people</td>
<td>Important to be explicit about task expectations.</td>
<td>Explore impact of negative expectations. Do more usability testing</td>
<td>Not tested on adolescents with anxiety</td>
<td>Colours, text-elements, illustrations, look and feel, navigation, instructions, reminders, choices,</td>
<td>Learnability, Customizability, Persuasive, Familiarity, Recoverability</td>
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<tr>
<td>Zhao [11], 2017, USA</td>
<td>Psychoeducational interventions for depression</td>
<td>Systematic review. Search of efficacy studies</td>
<td>55 studies included</td>
<td>List of interventions, their content and effectiveness.</td>
<td>Only descriptive</td>
<td>Feedback, chat, social community, reminders,</td>
<td>Customizability</td>
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</table>
### Rice [12], 2016, Australia

#### Online social therapy intervention for depression relapse prevention in young people.

- **Single group pilot study.**
- Designed through participatory design principles.
- To be more engaging and effective there should be an increasing amount of interactivity and support from peers and moderators.
- Proof of concept—not sure about the true clinical benefits. No details on design.

### Rento [13], 2014, Canada

#### What web-delivered programs for depression are available?

- Find 32 programs on Google Descriptive.
- Programs should use feedback from users to target the specific population.
- Future research should examine which aspects of a program could promote retention and completion.
- Google search might have missed some programs.

### Pham [14], 2016, UK

#### Online mobile game for managing anxiety (breathing retraining)

- Unblinded, parallel group RCT. Questionnaires (quantitative).
- No clinical effect but engaging and acceptable and useable.
- Gamified retraining might be useful for other groups (asthma or so).
- Self-reported

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**Author Manuscript**
<p>| Mohr [15], 2010, USA | Multimodal internet-based treatment of depression with Telephone support | One-armed feasibility study. Questionnaires (quantitative) + telephone interview (qualitative) | n = 21 | Good adherence properly due to manualized telephone support and short sessions | Started an RCT on the telephone support and internet intervention | Preliminary results (feasibility). No control group. | Look and feel of video recordings, feedback | Persuasive, Simplicity, Task Migrability, |
| Lauritsen [16], 2017, Denmark | Electronic self-assessment tool in depression Interview and questionnaires | n = 45 | Good usability | Improvement could be: daily feedback from clinician, alarms connected to mood ratings | Design considerations in workshop description (Løventoft, 2012) | Illustrations, Colours, Social community | Simplicity |</p>
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>Participants</th>
<th>Intervention</th>
<th>Measures</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kobak</td>
<td>In-session use of tablets and text messaging between CBT sessions for depression</td>
<td>2015, USA</td>
<td>Pilot study, Questionnaires (quantitative)</td>
<td>n = 18 (clinicians), 65 patients (adolescents)</td>
<td>It is possible to do augmented CBT where you use ICT element in current face-to-face-treatment to engage and personalize treatment instead of creating the entire program.</td>
<td>Future research should spread more light on which elements of ICT is helpful</td>
<td>Only questionnaires - no interviews</td>
<td>Reminders, Goal-setting, self-monitoring, Customizability, multitasking</td>
</tr>
<tr>
<td>Kemmeren</td>
<td>Blended Care for depression (E-compared)</td>
<td>2016, Netherlands</td>
<td>Protocol N/A</td>
<td>Measure on frequency, number of visits, time-in between visits, duration, order, completion</td>
<td>N/A</td>
<td>N/A</td>
<td>Feedback, motivational messages</td>
<td>Stability, Responsiveness, Functionality</td>
</tr>
<tr>
<td>Author</td>
<td>Title</td>
<td>Methodology</td>
<td>Sample Size</td>
<td>Findings</td>
<td>Implications</td>
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<tr>
<td>Kelder [19], 2013, Netherlands</td>
<td>Web-based intervention (ACT) for indicated prevention of depression</td>
<td>Literature scan and usability testing (qualitative)</td>
<td>18 interviews, 10 for usability test, 8 for Cognitive walkthrough (experts)</td>
<td>Support is essential for an effective intervention. Reminders can enhance effectiveness. Diaries for self-monitoring is a useful persuasive tech</td>
<td>Experts are good at &quot;pretending&quot; to be users. But still recommends use of both user and experts usability test.</td>
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<tr>
<td>Van Gemert-Pijnen [20], 2014, Netherlands</td>
<td>Web-based intervention for depression (ACT)</td>
<td>Log-analysis (quantitative)</td>
<td>Log data from 206 patients</td>
<td>Decrease in logins and use of content and persuasive features over time. The use of feedback did not change over time</td>
<td>Better integration of content and persuasive features in the design. Need to combine these results with qualitative results.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Ho [21], 2016, USA</th>
<th>Peer-networked online intervention for depression prevention among adolescents</th>
<th>Qualitative feedback semi-structured phone interview and log data (quantitative)</th>
<th>n=13</th>
<th>Peer network might increase adolescent engagement</th>
<th>Avoid confusion on how to use CBT-functions.</th>
<th>Small sample size, not the right target population. Need comparison to non-networked intervention.</th>
<th>Colours, illustrations, navigation, reminders, social community, uncomplicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bae [22], 2009, Korea</td>
<td>Health information system for depression symptom management</td>
<td>Need assessment (literature review), analysis (focus group interviews), design/development/testing (focus)</td>
<td>Focus group of 10 professionals, 5 patients and 5 family members</td>
<td>User-centred design was used to make a cultural sensitive website.</td>
<td>Because of stigma related to psychiatric disorders in Korea, web based therapy has a great advance.</td>
<td>No clinical outcomes</td>
<td>Text-elements, illustrations, cultural differences, navigation, social community, chat</td>
</tr>
<tr>
<td>Author and Year</td>
<td>Study Design</td>
<td>Sample Size</td>
<td>Focus Groups</td>
<td>Usability Testing</td>
<td>Comments</td>
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<tr>
<td>Danaher [23], 2012, USA and Australia</td>
<td>Web-based intervention for symptoms of postpartum depression</td>
<td>Focus groups and usability testing (qualitative + quantitative)</td>
<td>Focus groups n = 17, usability test n = 22</td>
<td>Red text draws attention, like to be able to make thing larger by clicking. Need to add more instructions</td>
<td>The usability testing goes on after the initially testing to keep improving. Groups were not representative enough (e.g. older than the target group).</td>
<td></td>
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<tr>
<td>Cartreine [24], 2012, USA</td>
<td>Computer-automated problem-solving treatment for depression</td>
<td>Failure analysis + questionnaires (qualitative + quantitative)</td>
<td>Experiment al group = 7, control group = 7 (minor depression)</td>
<td>High SUS-rating (80.4 compared to average of 70.1 (in general not in treatment of depression))</td>
<td>Should be compared to text based problem solving treatment, Small sample size, - highly preliminary.</td>
<td></td>
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</tbody>
</table>

Customizability, Synthesizability, predictability, media-richness

Look and feel of video recordings, illustrations, social community, activity tracking, journal, self-monitoring, navigation

High SUS-rating (80.4 compared to average of 70.1 (in general not in treatment of depression))

Should be compared to text based problem solving treatment, Small sample size, - highly preliminary. |

Look and feel of video and audio recordings, instructions, print out, feedback, activity planning

Familiarity, predictability, media-richness

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<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Methodology</th>
<th>Sample Size</th>
<th>Findings</th>
<th>Key Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Gaming features in web based interventions for common mental disorders and well-being</td>
<td>Systematic Literature review of RCTs</td>
<td>61 RCTs</td>
<td>No studies examined the role of gamification on program adherence. Adherence could be affected by other elements than gaming features.</td>
<td>Game-elements, feedback, goal setting, Persuasive, Customizability</td>
</tr>
<tr>
<td>Lara</td>
<td>Web-based help for depression</td>
<td>Log data analysis</td>
<td>n = 17318</td>
<td>61% entered discussion forum (only 16% of these posted something), feedback, social community, journal</td>
<td>Feedback, social community, journal, points</td>
</tr>
<tr>
<td>Author</td>
<td>Description</td>
<td>Methodology</td>
<td>Participants</td>
<td>Key Findings</td>
<td></td>
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<tr>
<td>Davids [27], 2014, USA</td>
<td>Mobile web-based behavioural activation intervention for depressed adolescents</td>
<td>Usability evaluation (qualitative) + log of usage data (quantitative)</td>
<td>n = 24 adolescents, n = 717 disaster affected adolescents</td>
<td>29% did not click through it all. Confusion about print out (what to do). There are so many more advantages of mobile technology / e.g. reminders</td>
<td></td>
</tr>
<tr>
<td>Currie [28], 2010, Canada</td>
<td>CCBT program to reduce symptoms of emotional distress.</td>
<td>Usability test (qualitative)</td>
<td>n = 10 college students (3 groups)</td>
<td>Primary changes made: 1) adding more explanations to navigation 2) shortening sections of text 3) braking modules up into two and reducing repetition 4) aesthetic appearance of text</td>
<td></td>
</tr>
</tbody>
</table>

Results consistent with literature on good web design. Early stages, few participants, not target group, text-elements, navigation, cultural differences, motivational messages, choices. Customizability, Task migratability, Synthesizability, Predictability.
<table>
<thead>
<tr>
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<th>Findings</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bickmore</td>
<td>How depressed people respond to relational agents compared to people who are not depressed</td>
<td>Using data from a parent study of hospitalized adults</td>
<td>n=131 (19 of whom had major depression)</td>
<td>Patients with major depression stated a significantly greater desire to continue interaction with the agent and they scored it higher on therapeutic alliance</td>
<td>Relational agents can work for both depressed people and people with low health literacy - could this be implemented in other systems?</td>
</tr>
<tr>
<td>Bresó</td>
<td>Description of an adaptive HCI-framework</td>
<td>Simulation (HCI) + pilot study</td>
<td>N/A</td>
<td>Patients with depressive symptoms may react more positively to any new intervention</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Element</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout and instructional design</td>
<td>Text-element (9), Colours (6), Illustrations (7), Sound of audio-recordings (5), Look and feel of video-recordings (8), Navigation (6), Instructions (7), Print out (4)</td>
</tr>
<tr>
<td>Social context and support</td>
<td>Chat (10), Social community – discussion forum (7), Personal stories (3), Reminders (10),</td>
</tr>
<tr>
<td>(simulations of or real</td>
<td></td>
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<tr>
<td>person-to-person interaction)</td>
<td></td>
</tr>
<tr>
<td>Contacts with the intervention</td>
<td>Feedback (11), Motivational messages (6)</td>
</tr>
<tr>
<td>Tailoring</td>
<td>Goal-setting (5), Customizable character (3-4) Game-elements (5), Choices (7),</td>
</tr>
<tr>
<td>Self-management</td>
<td>Activity planning, activity scheduling, activity tracking (8), Self-monitoring (9), Diary, journal (5)</td>
</tr>
</tbody>
</table>

(Numbers in ‘components’ column denotes the cumulative tally for the stated component across all articles included in the review)