

Human Centered Development of a Web-based Intervention for the Prevention of Depression

Saskia M. Kelders

Center for eHealth Research & Disease Management
University of Twente
Enschede, the Netherlands
National Institute for Public Health and the
Environment
Bilthoven, the Netherlands
s.m.kelders@utwente.nl

Maarten Jan Oskam, Ernst T. Bohlmeijer, Julia

E.W.C. van Gemert-Pijnen

Center for eHealth Research & Disease Management
University of Twente
Enschede, the Netherlands
mail@maartenjan.com;
e.t.bohlmeijer@utwente.nl;
j.vangemertpijnen@utwente.nl

Abstract—Web-based preventive interventions have shown to be effective for the prevention of depression, but high rates of non-use and drop-out, less than optimal implementation in the care organization and low acceptance rates cause interventions to be less effective in practice than in theory and research. The lack of a holistic overview where the human and technological context is given a prominent place, seems to be one of the main reasons for this less than optimal effectiveness. This study employs methods based on the holistic approach of the CeHRes roadmap to create a viable web-based intervention and to investigate the suitability of the chosen methods and the pitfalls that can be encountered. The study shows that it is possible to create a viable web-based intervention by including different stakeholders (users, designers, programmers, researchers) in different phases of the development process. The employed methods are suitable and yield complementary results, but made our approach more user and expert driven than fully stakeholder driven. Furthermore, our project team was organized with the researcher as the central hub. Although this worked well most of the time, we propose a more ideal organizational structure in which a formal project leader, who can be a researcher, has a mandate to make decisions and resources to be involved in all steps of the process.

Keywords—Human Centered Development; Web-based Application; eHealth; Holistic; Design; Depression.

I. INTRODUCTION

To reduce the large public health burden of the high prevalence of depression, early interventions targeted at people at risk are essential and can be cost-effective [1, 2]. However, recruiting participants for interventions to prevent the onset of depressive disorders is quite a challenge [3]. Developing and implementing web-based preventive interventions might provide an opportunity to overcome this challenge [3, 4]. Advantages of web-based interventions can be seen not only in the broader reach, but also in increasing convenience for the users, the opportunity to provide information in an interactive and timely manner and cost-

effectiveness [5-7]. Meta-analyses show that these interventions, on average, do have a positive influence on the severity of the complaints [8, 9]. Nonetheless, there are drawbacks of online interventions. High rates of non-use and drop-out, less than optimal implementation in the care organization and low acceptance rates cause interventions to be less effective in practice than in theory and research [10-13].

Many studies are done to investigate the effect of a web-based intervention solely on clinical outcomes, without attention for the organizational and technical context [13]. Especially the technology is seen as a given, only the effect can be subject to research. In development, this leads to a technology push: technology is developed because of the technological possibility, not because the target group needs the technology. The lack of a holistic overview where the human and technological context is given a prominent place, seems to be one of the main reasons that web-based interventions do not reach their full potential [13-15].

Recently, other approaches that take into account the context of the developed technology are gaining ground in the development of web-based interventions. Human centered design, which advocates the systematic, continuous consultation of potential users during the whole design process, is one of these approaches [16] and has been shown to have a positive effect especially on user satisfaction and fitting to user needs [17]. User satisfaction can be seen as an aspect of usability, which has been defined as: 'The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use' [18]. Fitting to needs of the users can be seen as an increased perceived usefulness of an application [19]. To ensure that these positive effects can be achieved, certain pitfalls should be avoided or dealt with in an appropriate manner. Common pitfalls that have been identified are: losing the focus on the user [20, 21]; a middle-of-the-road design [14, 22]; an uninvolved project leader [23].

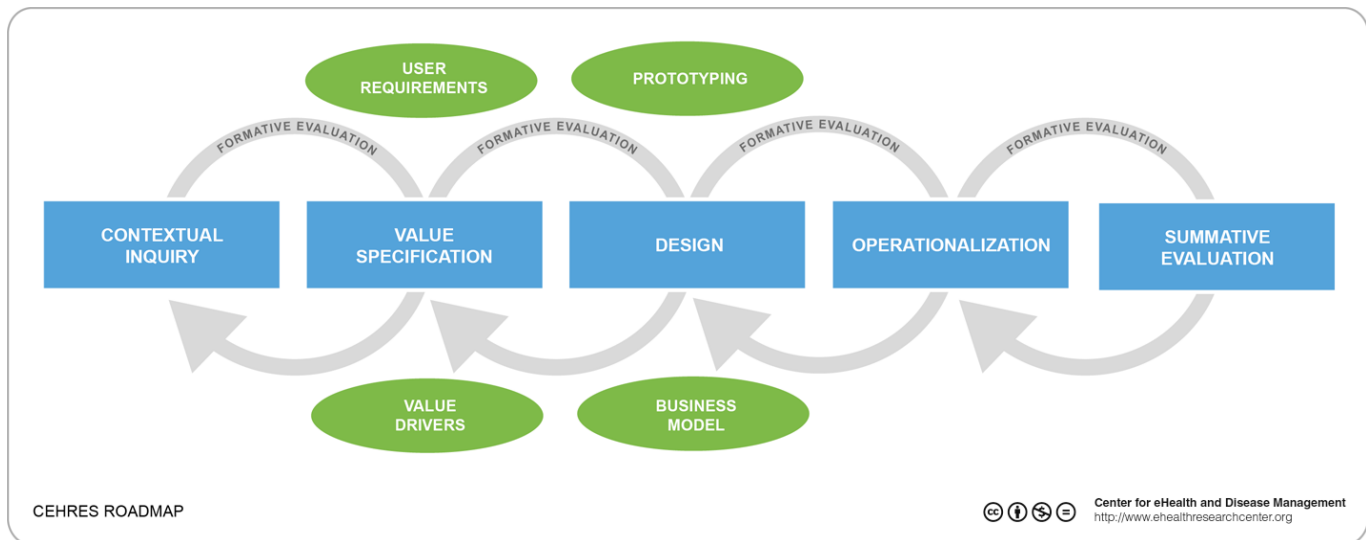


Figure 1. CeHRes roadmap

Another approach that is gaining ground in eHealth development is business modeling, which focuses on creating an optimal fit between the technology that is being developed and the organizational resources and capabilities to create a sustainable technology [24]. A framework that combines both approaches is the CeHRes (center for eHealth research) roadmap [15]. The roadmap with five main phases in the development process is shown in figure 1. The combination of human centered design and business modeling in this framework might provide a means to help achieve the full potential of a web-based intervention for the prevention of depression.

In this paper, we describe a study into the development of a web-based intervention for the prevention of depression, employing methods from the CeHRes roadmap. The goal of the study is twofold. The first goal is to create a viable web-based intervention, that is attuned to the needs and wishes of the end-users and fits the organizational context for which it will be developed. The accompanying research question is: What usability and usefulness issues are detected by employing a human centered design process? The second goal is aimed at the process: We aim to investigate the suitability of the chosen methods, the pitfalls we encounter and ways to cope with these pitfalls. The accompanying research questions are: How suitable are the employed methods? What pitfalls are encountered and what lessons can be learned from this?

The significance of the first aim of the study is obvious for the application being developed, but additionally, when developing similar web-based applications, the results can be used as a vantage point. The significance of the second aim is much broader. New web-based applications are developed at a startling rate, but there is no scientifically underpinned agreement on how to best develop these applications [14] (for example of an ad hoc development see [25]). The results of this study will provide a starting point for future development of web-based interventions.

II. METHODS

A. Content of the Intervention

The web-based intervention for the prevention of depression developed during this study is called 'Living to the full'. This intervention is based on acceptance and commitment therapy (ACT) and targets experiential avoidance that can be considered as a generic risk factor for mental illnesses [26]. The intervention as a group format and as a guided self-help format with email support by a counselor have both shown to be effective in reducing depressive symptoms [27-29]. The content of the web-based intervention has been adapted from the self-help book 'Living to the full' [30].

B. Value Specification

In this phase of the CeHRes roadmap it is determined which values the different stakeholders deem important. These values and prospective users' needs and wishes need to be translated into functional and organizational requirements. For this study we have chosen to employ interviews, rapid prototyping and a feedback session (Table I) to assess the needs and values of the target group and to translate them into requirements for the application. Interviews and rapid prototyping were conducted with prospective end-users, i.e., people with mild depressive symptoms who are willing to participate in a preventive intervention. The feedback session to translate the needs and values of this target group into requirements was conducted with researchers, designers and programmers.

1) Interviews and Rapid Prototyping

Semi-structured interviews were performed to identify the needs and requirements of the target group and the usefulness of various possible functionalities of the system. The interviews were combined with rapid prototyping [31]. In total, 18 interviews were conducted. The interview participants were recruited from a previous study into the

effectiveness of ‘Living to the full’ as a guided self-help format with e-mail support [28]. Our participants were not able to participate in that study because of an overwhelming number of responses, but were willing to participate in our study. All participants received a gift voucher for their participation. Prior to the interview, the interviewer explained the goal and process of the interview, obtained permission to audio record the interview and each interviewee signed an informed consent. A typical interview lasted about 45 minutes.

TABLE I. OVERVIEW OF RESEARCH ACTIVITIES AND INSTRUMENTS

Research phase	Research activity	Research method
Value specification	Assessment of needs and values of target group.	Interviews & Rapid prototyping
	Translation of needs and values in requirements.	Feedback session (researchers, designers & programmers)
Design	Usability assessment by target group.	Usability testing
	Usability assessment by experts.	Cognitive Walkthrough
	Prioritizing points for improvement.	Feedback session (researchers, designers & programmers)

The interview scheme was based upon eHealth and Human Centered Design literature [15, 21, 31, 32] and consisted of three parts. Part 1 focused on previous experience with the content of the intervention (ACT) and with web-based interventions in general. Furthermore, the needs and requirements were discussed by asking three cruxes that the web-based intervention has to satisfy and one thing that would be a reason to quit (or not start) the intervention. Rapid prototyping was part 2 of the interview and focused on the usefulness of three parts that were available as a paper prototype, i.e., text message coaching, online diary and feedback. Part three assessed demographics, such as age, education and internet experience.

The interviews were not transcribed, but were analyzed within 48 hours after the interview had taken place, according to the guideline of Holtzblatt [33]. We used a thematic analysis to identify patterns in the responses [34]. Part 1 was analyzed by translating the cruxes and reasons to quit into needs and values. Part 2 was analyzed by counting the number of respondents who would and would not like to use the different features. Further information was coded using a thematic analysis. All analyses were done by two independent coders.

2) Feedback session

The results of the interviews and rapid prototyping were communicated to the designers and programmers by means of a report written by the researchers. This report was presented and discussed with the development team of the web-based application to translate the needs and values into requirements. The researchers specified the most important needs and values and the development team used their expertise to implement these requirements into the prototype of the application.

C. Design

In this phase of the roadmap, (a prototypical version of) the technology is developed, based on the requirements. The framework advocates the application of cooperative design in which the design team creates the technology with prospective users and stakeholders together. For this study we have chosen to employ think aloud usability testing with the target group and a cognitive walkthrough with experts (Table 1) to assess the usability and usefulness of the web-based application.

1) Usability testing

Usability testing was used to assess the usability of the application by the target group. We employed a scenario-based think aloud protocol [35], i.e., respondents were guided through the application by means of scenarios that pose a problem or task that might be solved or completed by using the program and respondents were instructed to verbalize their thoughts during the whole process of the test. We conducted 10 usability tests. Participants were recruited using online advertisements and were part of the target group of the web-based intervention. All participants received a gift voucher for their participation. All usability tests were recorded and coded retrospectively. The material (audio and video) was reviewed and issues were identified by the researcher. Verbal comments as well as actions taken by the respondents could be coded as issues. These issues were analyzed using a coding scheme based upon the subconstructs of the ISO definition of usability [18] following the work of Hornbaek et al. [36].

2) Cognitive Walkthrough

The cognitive walkthrough method was used to assess the usability of the application by experts. This method was used in addition to usability testing by the target group to gain a broader overview of the usability of the application [35]. Eight experts of the University of Twente conducted the cognitive walkthrough. Issues were coded using the same coding scheme as used for the usability testing.

3) Feedback session

The results of the usability testing and cognitive walkthrough were communicated to the designers and programmers by means of a report written by the researchers. This report was presented and discussed with the development team of the web-based application to prioritize the points for improvement.

III. RESULTS

A. Value Specification

The mean age of the 18 respondents was 45 years (sd = 10), 78% (n = 14) was female and 78% (n = 14) has completed at least higher vocational education. The needs and values that arose from the interviews are presented in Table II.

67% (n = 12) respondents indicated that they would use text message coaching. 11% (n = 2) would not use this feature and for the remaining 22% (n = 4) using this feature depends on the content of the text messages. Reminders (n = 11) are seen as the most useful content for the text messages,

although assignments ($n = 6$) and motivation ($n = 4$) are also seen as useful content.

The possibility of an online diary was received with mixed reactions. 44% ($n = 8$) would definitely use it and thought of it as a pleasant addition. However 56% ($n = 10$) would only use the diary when it is part of an assignment in the course.

TABLE II. NEEDS AND VALUES

Needs and values	n
Functional design application	12
Feedback/contact with counselor	8
Added value of content	8
Flexible schedule of doing the course	6
Contact with others using the application	6
Attractive application	5
Fixed endpoint	3
Specific/clear instructions	3
Limited time investment (content and assignments to-the-point)	3
Personal attention	3
Encouragement to complete the course	3
Focus on 'real-world' of the users	1

All respondents indicated that feedback would be useful and even essential. Feedback is expected on assignments, but it can also be useful for gaining new insights, support and motivation. Several respondents ($n = 5$) stress the importance of the feedback being personal.

Based on the results of the interviews and rapid prototyping, a report with recommendations was written by the researchers and communicated with the design team. The recommendations were prioritized and an action plan was agreed on.

B. Design

The mean age of the 10 participants of the usability test was 38 years ($sd = 11$), 90% ($n = 9$) was female and 70 % ($n = 7$) has completed at least higher vocational education. The 8 participants of the cognitive walkthrough can be categorized as usability experts ($n = 7$) and target group experts ($n = 1$) [33]. In total, both methods yielded 476 issues, virtually equally distributed between the usability testing and cognitive walkthrough (respectively 52% ($n = 242$) and 48% ($n = 225$)). Table III shows the distribution of the issues over the subconstructs of usability and the amount of positive (+), neutral (+/-) and negative issues.

TABLE III. ISSUES DESIGN PHASE

	Usability testing				Cognitive Walkthrough				total
	+	+/-	-	total	+	+/-	-	total	
Effectiveness	12	3	76	91	0	0	85	85	176
Efficiency	20	3	31	54	0	0	1	1	55
Satisfaction	45	5	47	97	29	3	107	139	236
Total	77	11	154	242	29	3	193	225	467

Issues ranged from the functioning of features (e.g., respondent cannot adjust the volume of the player of the mindfulness exercise; usability test, respondent 6); to layout (I like the colours, usability test, respondent 11); and to the

lack of options (The mindfulness exercise should have the option to download the exercise as mp3-file; cognitive walkthrough, respondent 6). As can be seen in Table III there were differences in the sort of issues both methods detected. Usability testing yielded more positive issues and the issues were more evenly divided over the subconstructs. The cognitive walkthrough yielded only 1 issue in efficiency and most issues were found in satisfaction.

Based on these 467 issues, 109 unique points for improvement were formulated. Of these points, 38 came forward in both methods, 19 were uniquely based on the usability testing and 52 were uniquely based on the cognitive walkthrough.

The 109 points for improvement were communicated to the design team, by means of a report in which the improvements were categorized by feature of the application (e.g., signing up; the first lesson). During the feedback session with the researchers, designers and programmers, a prioritization was made, based on the study results and the estimation of the estimated effort (time and money) to implement the points of improvement.

IV. CONCLUSION AND DISCUSSION

A. Application

Our first research question was aimed at identifying usability and usefulness issues by employing a human centered design process. The study has shown that employing the chosen research methods yielded many issues related to the application. Regarding usefulness, our results show that the most important needs and values of the target group are a functional design of the application, feedback or contact with a counselor and the importance of added value of the content of the intervention. Furthermore, we have seen that text message coaching seems a viable feature of the web-based intervention, as long as the content of the text messages serves as a reminder, an assignment or is motivational. An online diary can be useful, under the condition that the diary is embedded in assignments. Moreover, feedback is essential for a web-based intervention for the prevention of depression. Regarding usability, the results yielded over 100 points of improvement on usability aspects of effectiveness, efficiency and satisfaction. Studies have shown the significance of a well attuned intervention to reduce non-use and dropout of an intervention [10-12]. By employing a human centered design process, we feel that we have succeeded in our goal to lay the foundation of a viable web-based intervention, that is attuned to the needs and wishes of the end-users and have thereby increased the expected future adherence to this intervention. However, the second part of our goal was to create an intervention that fits the organizational context for which it will be developed. Due to the methods we have used, our approach was more user and expert driven than fully stakeholder driven. The care professionals and the organizational context, might not have been given the appropriate attention. Nevertheless, the developed intervention seems to be viable for the end-users in their context.

B. Process

The research questions that accompany our second research aim were focused at the suitability of the employed methods, the pitfalls we encountered and the lessons we have learned. The methods used in the value specification phase seem to be suitable. They have yielded valuable information on the needs of the target group and the usefulness of different features. However, according to the CeHRes roadmap [15] and human centered design literature (e.g., [32]), participation of the target group should start before the value specification phase. In this study the researchers and the design team have decided in advance that the target group has a need for the intervention and the chosen mode (web-based). Therefore, other modes (e.g., mobile, devices) have not been considered and the actual *need* for a web-based intervention has not been researched. We feel that, for this topic, there is enough evidence to support the significance for web-based interventions [1-9], but it is important to always assess ones assumptions before trusting them blindly.

For the design phase we used a target group method (usability testing) and an expert method (cognitive walkthrough). Interestingly, the expert method yielded far more unique points of improvement than the target group method. This is in line with the overview of usability methods of Jaspers [35] that states that in a later stage of development expert methods might yield more usability results. An explanation might be that end-users find it harder to separate the content and context from functional characteristics of a system [14]. This might also explain the differences in the distribution of the issues over the subconstructs effectiveness, efficiency and satisfaction. Nevertheless, in line with the CeHRes roadmap, we feel it is important to view the system not as a stand-alone application, but in its context. Therefore, although the target group method did not yield as many unique points for improvement, it is still an important part of the design phase, especially because the end-users do not see the application separate from its context.

In this study, we have made a first step in developing a web-based intervention for the prevention of depression following the CeHRes roadmap. Although we have included different stakeholders (users, designers, programmers, researchers), care professionals and the organization in which the intervention will be implemented have not been involved. This makes it hard to investigate whether the developed intervention fits the organizational context for which it is developed. Including these two important stakeholders in future research might lead to a better organizational fit. In the value specification phase, this could be realized by employing focus group methods and in the design phase by usability testing combined with interviews [15].

In the development process, we have encountered all of the common pitfalls described in the introduction (losing the focus on the user; a middle-of-the-road design; an uninvolved project leader) to a certain degree. Losing the focus on the user was seen most prominently in discussing

and prioritizing the points of improvement in the design phase. Time and costs can quickly become more important than the needs and wishes of the users. It would have been better to involve the users in prioritizing the points for improvement. The pitfall of a middle-of-the-road design was also encountered in the design phase when users reacted differently on design ideas. For example, a sentence that was intended to rouse curiosity was found to be provoking for some participants and therefore tuned down. We did not encounter the pitfall of an uninvolved project leader as such, but we did encounter difficulties in the project team and interdisciplinary issues. Our project team consisted of researchers, designers and programmers. There was no formal project leader, instead one of the researchers took this role. The project team was organized with the researcher as the central hub. Although this informal project management worked well most of the time, there were instances where the informal project leader did not have the authority to make certain decisions or the resources to be involved in all aspects of the development process. These issues have led to time delays and confusion. A more ideal organizational structure based on our experiences and literature can be found in figure 2 [14, 23, 32]. In this figure, the project leader might be one of the researchers, provided that adequate resources and has a mandate to make decisions in the development process.

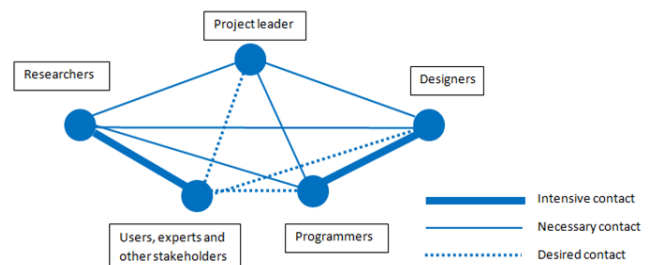


Figure 2. Ideal organizational structure

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