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Development and preliminary testing of a web-based, self-help application for disaster-affected families

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Abstract

Technology-based self-help interventions have the potential to increase access to evidence-based mental healthcare, especially for families affected by natural disasters. However, development of these interventions is a complex process and poses unique challenges. Usability testing, which assesses the ability of individuals to use an application successfully, can have a significant impact on the quality of a self-help intervention. This article describes (a) the development of a novel web-based multi-module self-help intervention for disaster-affected adolescents and their parents and (b) a mixed-methods formal usability study to evaluate user response. A total of 24 adolescents were observed, videotaped, and interviewed as they used the depressed mood component of the self-help intervention. Quantitative results indicated an above-average user experience, and qualitative analysis identified 120 unique usability issues. We discuss the challenges

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of developing self-help applications, including design considerations and the value of usability testing in technology-based interventions, as well as our plan for widespread dissemination.

Keywords
ehealth, evidence-based practice, healthcare service innovation and IT, IT design and development methodologies, telecare

The use of technology in delivery of evidence-based care may improve treatment dissemination and reduce common barriers to treatment.[1,2] Self-help interventions, such as Internet-based websites or mobile applications, offer opportunities to increase access to evidence-based interventions in a cost-effective and convenient manner. With self-help interventions, patients can learn and practice new skills at the time and location of their choosing. The research literature on the efficacy and feasibility of self-help website interventions is promising, including several interventions for patients with depression[3–6] and other traumatic stress-related conditions.[7–9] Findings are also encouraging for web-based interventions targeting anxiety, depression,[10] and substance[11] use in children and adolescents.

In particular, there is a tremendous need for highly accessible, evidence-based mental health interventions for families in the aftermath of disasters, mass violence, and other large-scale incidents. Disasters can affect thousands to millions of lives simultaneously, and healthcare systems have limited capacity to manage the mental health needs that arise in the weeks and months that follow. Adolescents with post-disaster mental health difficulties are unlikely to be identified and receive treatment as a result, despite how they may suffer from a wide range of mental health problems such as anxiety, depressed mood,[12] and increased substance use.[13] Furthermore, at-risk adolescents and adults who might benefit from mental health services are hesitant to seek formal treatment[14] partly due to fears of being stigmatized if they were to seek formal in-person treatment.[15] Therefore, it is important to make accessible alternative forms of intervention that encourage, but do not require, users to interact with healthcare professionals. In a stepped-care approach, remote web-based interventions could provide the first line of treatment, as well as provide information about seeking in-person help for those who require and are willing to seek additional treatment.

The potential benefits of web-based, self-help interventions are tremendous. However, the development of such applications is a complex endeavor that poses unique challenges.[16] Application development is a multi-stage process, often starting with a needs assessment and iterative phases of content design and refinement.[17] The development team often encounters a series of programming and web design issues in the process of developing the product; decisions at this level may affect user motivation and adherence to the intervention once the application is deployed. Comprehensive iterative rounds of testing assist in identifying and fixing errors in programming and improving user experience. Once the application is deployed, evaluation of user reactions and marketing strategies may be key next steps. The entire development process often requires a team of workers, and it may take months or even years to create an effective application that appeals to the consumer. After the application is released, additional maintenance typically is required, such as providing updates, fixing unidentified or newly developed bugs, releasing new versions, and providing technical support to users.

In the development of any website or application, it is important to make design decisions based on the specific audience (e.g. adolescents) and to assess user reactions carefully.[17] Applications that

are difficult or frustrating to use affect the patient's motivation and ability to continue using the product and engage in the treatment.[18] An application that is well designed can have positive effects on user adherence and treatment outcome, whereas a poorly designed application may not retain users. For example, the consumer's ability to find, read, and understand relevant information affects their dose–response to the intervention, their knowledge gain, their adherence to the intervention, and likely their motivation—all of which have been indicated as factors significantly affecting treatment outcome for traditional in-person interventions.[17] Products developed for adolescents and children pose unique challenges, as a user's experience may be affected by developmental factors, such as education, reading/writing level, attention span, and relatability of the material.[19] As such, users' experiences become increasingly important to assess for self-help applications targeting adolescents.

Usability testing is a *human factors* methodology that explores the user's experience with the product by having a representative sample of consumers use the application while being observed by researchers. These observations are systematically recorded and later analyzed and interpreted to gain a unique depth of understanding around user experiences with the product. Several published studies have explored how usability testing can improve user experiences with self-help websites targeting physical health problems such as smoking and obesity.[20–24] However, there is a dearth of published literature on the use of this application development process for improving mental health interventions (e.g. for depression, anxiety, and post-traumatic stress disorder (PTSD)), and it is believed that most mental health professionals have limited knowledge of the "best practices" in application development.[17] Given the potential impact of usability on intervention effectiveness and the cost of development, it is important to highlight the role and application of usability testing in the development of technology-based mental health interventions.

Given the need for easily accessible mental health resources after a natural disaster, our research team developed a web-based, self-help application, called Bounce Back Now (BBN),[25] targeting adolescents aged 12–17 years old. We chose this population because disaster-affected adolescents are at risk for mental health difficulties (e.g. PTSD, depression, substance use), but there are limited existing resources for them. Web interventions may be particularly appealing to the younger generation that is growing up with this rapidly developing technology. Note that we had to limit the range of targeted ages due to developmental considerations such as reading level and age-based appeal. It is our hope that the intervention will help adolescents and their families identify post-traumatic stress pathology at an early stage, as well as become more familiar with evidence-based strategies to address mental health problems, which may improve their comfort level with psychosocial treatments and may motivate them to seek formal services if needed. This article describes the following: (a) the development process of a web-based, self-help application (BBN) targeting disaster-affected adolescents and (b) the utility of a formal usability study in which we evaluated user reactions to the application's mood module.

Development of the BBN application

Overview

We designed the BBN application with three main goals. First, this self-help website needed to provide education and behavioral recommendations for a wide range of mental health problems to ensure high relevance across disaster-affected populations. Second, the application needed the ability to capture changes in knowledge, motivation, and symptoms as the user progressed through the modules. Third, the application needed to provide psychoeducation and practical recommendations to the adolescents' parents.

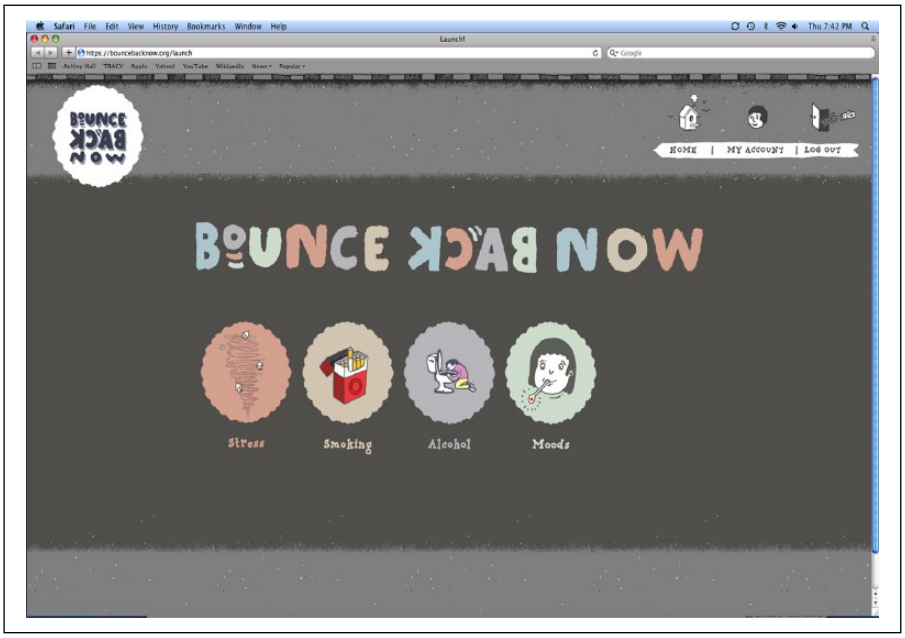

Figure 1. Splash page of the self-help application.

To achieve these aims, we decided to organize the website into several specific modules addressing the most common symptom areas for disaster-affected adolescents: *Stress and Anxiety* (addressing post-traumatic stress), *Mood* (addressing depressed mood), *Smoking*, and *Alcohol Use.* We also decided to build knowledge quizzes and behavioral rating scales into the application, allowing us to tailor the intervention to each user. Finally, we decided to include a section in the application to teach parents about symptoms that their teenagers may be experiencing, how to assess problematic changes in their adolescent's behavior (e.g. social withdrawal, changes in school performance), and strategies to foster their adolescent's resilience or rapid recovery. This decision was based, in part, on prior research highlighting the importance and value of parental involvement in their child's recovery after stressful life events.[26,27]

Application structure

After entering their username and password, the adolescent user is presented a splash page (see Figure 1) offering entry to any of the four main modules. Each module begins with 3–4 screening questions to assess the hallmark symptoms targeted by the module. For the *Mood* and the *Stress and Anxiety* modules, users who do not report significant symptoms are invited (but not required) to exit the module and told that they may find other modules more valuable. Users who do report significant symptoms are encouraged to complete the module. For the *Alcohol* and *Smoking* modules, users who do not report symptoms are not displayed the full module but still receive prevention-oriented content.

The modules were developed based on evidence-supported cognitive-behavioral techniques. Although some of the language in the modules is tailored to families affected by natural disaster, almost all of the content is applicable to a broader range of families affected by stressful life events in general. The *Stress and Anxiety* module was designed to provide psychoeducation as

well as evidence-based recommendations focusing on exposure exercises, reduction of avoidance of traumatic cues, coping strategies and anxiety management.[27] The *Mood* module was designed to feature behavioral activation strategies, which have shown promise as easily understood, efficacious, parsimonious, and cost-effective approaches in the treatment of depression.[28–30] The *Smoking* and *Alcohol* modules made use of combined brief motivational-enhancement and cognitive-behavioral strategies that have received promising support in the literature.[31] These strategies include elements that specifically address the needs of adolescent populations such as teaching skills to (a) refuse substance abuse offers from peers, (b) establish a positive family and peer network that is supportive of the youth abstaining from use, (c) develop a plan for positive, enjoyable activities to replace substance use-related activities, and (d) cope with stressful and/or high-risk situations.[32]

Parents who log into the application are not given access to the adolescent modules, but are instead given access to a Parent self-help module. The Parent module was designed to provide education about common symptoms of depression, anxiety, and problem behavior among adolescents who experience traumatic life events. Next, parents had the opportunity to choose between receiving more detailed education relating to adolescent problem behavior (e.g. delinquent behavior, substance use, curfew breaking) or to adolescent anxiety and depression. After they completed the section of their choosing, they were given another choice to (a) enter the other in-depth education section that they had not yet competed or (b) exit the parenting module. In the module, parents were provided education that addressed communication, parental monitoring and supervision, family routines and relationships, and identification and appropriate responses to anxiety, depression, or problematic behavior.

Age-related considerations

Tailoring the design of the application to an adolescent population presented many unique challenges. Adolescent brains are not yet fully developed, and attention, patience, metacognition, and understanding of abstract concepts are still emerging.[33] Cognitively, adolescents still struggle with flexibility and perspective-taking,[33] and reading skills in this age range also vary widely. Therefore, the website required engaging methods to teach prevention and intervention strategies for a wide range of learning styles while simultaneously catering to short attention spans, limited vocabulary, and reading skills.

The content was developed to be concrete and clear, with frequent examples, illustrations, and interactive activities to retain the young user's attention. Simple, straightforward language was used with a streamlined vocabulary and a minimal use of clauses. Popular, trendy colors were used as well as a wide range of creative design graphics. Illustrations were used to provide humor and maximize engagement, as well as to highlight important core concepts to the intervention. The popularity of cartoons and "doodles" among this age group also inspired us to use them in various illustrations and explanations. For example, the Smoking module reviews negative short- and long-term consequences of cigarette use through use of a human body doodle. The user can click on different parts of the body to learn more about smoking outcomes and how they affect that area of the body (e.g. heart, skin, hair). We also used other types of activities such as quizzes, videos, tools, and roll-over content throughout the modules to maximize engagement.

Egotism and sense of invincibility are also developmental hallmarks of this age,[34] which necessitated a unique approach toward emphasizing potential consequences of risk behavior that might be most salient to adolescents. For example, we identified weight gain as a consequence of alcohol consumption, and negative perceptions from dating partners as an undesirable consequence of smoking. In addition, challenges to inaccurate beliefs about peers' perceptions of their behaviors

and emotions (e.g. visibility of panic symptoms, perceptions of non-drinkers, sharing emotions associated with exposure to traumatic life events) were integrated throughout the modules.

In the Parent module, the images, layout, and color choices were more mature compared to the modules targeting adolescents. However, it was important to maintain the *BBN* visual identity and branding throughout, which was maintained between the adolescent and parent modules with stylistic similarities in tone.

Privacy

Adolescents' desires for independence and privacy[35] were addressed through the use of individual usernames and passwords. Only the adolescent logged into the application is able to view her or his own personal information and responses. Parents logged into the application under their own "parent" account are unable to view their child's responses (e.g. disclosures of cigarette use). In addition, reminders about privacy limitations on the web and suggestions about ways in which adolescent participants could enhance their privacy (e.g. completing writing activities in a quiet, private location) were also included throughout the modules.

Web security

Users were informed about the security features of the site at the outset of their participation (on the log-in screen). We also used several approaches to preserve anonymity of users' data. For example, we separated user information collected via the site into different tables, each of which is indexed by a cryptographic hash function (Secure Hash Algorithm 1 (SHA-1)) of the user's id. This allowed data to be entered by the user during their session while restricting the ability for the data to be accessed by outside individuals, thereby adding another layer of protection to user data. Furthermore, we employed a secure sockets layer (SSL) encryption of all user data, not unlike the encryption approach employed by financial institutions and government agencies to encode and protect their information from illicit hacking.

Testing and evaluation

Upon completion of the initial build, the development team spent several weeks testing the modules and correcting any errors or points of confusion that were encountered. We also decided that usability analysis was a top priority because users who respond negatively to an application may be less motivated to continue using it and benefit less from its content. Furthermore, we wanted to directly observe adolescents' interactions with the site in order to identify the full breadth and depth of usability issues. To assess specific and detailed user reactions in real-time, we conducted a formal usability study for the Mood module of the BBN application.

Formal usability study

One of the main purposes of a usability study is to obtain objective usability metrics and uncover usability issues. Common usability issues include anything that prevents task completion, takes someone off course, creates confusion, or decreases satisfaction—examples include performing the wrong action, misinterpreting something, disliking a specific feature, and not understanding the navigation.[36] Many of these issues are not initially noticed until observed in real-time by a representative user during a usability study. As usability issues are identified, they are prioritized, and then revisions are made to the application, thus improving the product's effectiveness and impact

on the users. Then, in an iterative process, additional rounds of usability testing are conducted to evaluate the latest version of the application. Although time intensive, formal usability testing may facilitate a higher return on the tremendous costs in time, effort, and money that have already been required to develop the application.[36]

Our research team conducted a formal usability study on the Mood module of the BBN application. The Mood module provides psychoeducation, behavioral exercises, and other tools to address depressed mood among adolescents. We decided to conduct formal usability testing on only one module due to limited resources and with the expectation that the conclusions gleaned from analysis of this module could generalize to the other modules. Similarities in format and functions that are featured throughout all of the modules are consistent with this expectation. The usability study had four key objectives: (1) obtain usability metrics, (2) identify major usability issues, (3) assess adolescents' reactions and satisfaction levels, and (4) provide recommendations for a future revision of the application.

Method

Participants. Participants were recruited using listserv messages and flyers posted at psychiatric clinics on a medical university campus. Recruitment from psychiatric clinics increased the likelihood that the intervention content was relevant to the needs of the participants, many of whom reported significant mental health symptoms as described below. Participants were 24 adolescents (58% female) ranging in age from 12 to 17 years old (mean = 14.12; *SD* = 1.57). Participants reported their race as White (67%) or Black/African American (33%). Of these, 13 percent identified their ethnicity as Hispanic or Latino. Of participants, 29 percent met the clinical cutoff for depression symptoms on the *Center for Epidemiologic Studies Depression Scale-10* (*CES-D*)[37] with a score of 15 or greater. The mean score on the CES-D was 13.5 (*SD* = 9.9). On the *UCLA PTSD Index for DSM-IV* (*Adolescent Version*),[38] the mean was 35.12 (*SD* = 15.68), with 29 percent of participants meeting the full criteria for probable PTSD. An additional 13 percent met criteria for partial or subclinical PTSD. One-third of the sample had prior experience with counseling or therapy, and of these, the majority (63%) had found treatment to be helpful.

All participants reported having used computers regularly and indicated that their household owned a computer; only one participant stated that their household did not have an Internet connection. This is consistent with national estimates from the Pew Internet and American Life Project. The majority of participants (71%) used the Internet on a daily basis. Most reported feeling comfortable (46%) or very comfortable (33%) using the Internet; a minority reported that they felt very uncomfortable (17%) using the Internet.

Procedures. Each usability session was scheduled for 90 minutes and began with reviewing the study procedures with the adolescent and their legal guardian. After consent and assent were obtained, the legal guardian was asked to sit in a separate waiting area while the adolescent remained in the room to complete the usability test. Participants were seated in front of a computer that was connected to a projector that displayed the computer screen on a wall behind the participant. This allowed study personnel to observe all movements on the website as the participant navigated through the mood module. In addition, the sessions were videotaped.

Prior to using the BBN application, participants completed a *demographics questionnaire*, which included questions about prior treatment and prior use of technology. Participants also completed the 10-item *CES-D*,[37] a commonly used and psychometrically supported screening tool for depression symptoms, and the *UCLA PTSD Index for DSM-IV Adolescent Version*,[38] a well-established and psychometrically supported measure to assess PTSD symptoms among adolescents.

Website visit. As participants visited the BBN website, they were instructed to provide *verbal feedback* by voicing their opinions about the website aloud in real-time for each page they visited. This "think-aloud" method allowed the capture of their immediate thoughts and feelings as they went through the website. When needed, the participants were prompted with open-ended questions such as "What are you thinking now?" and "Go ahead and say your thoughts and feelings aloud." In addition, researchers recorded the participants' *behavior.* This included participants' interactions with the website (e.g. mouse movements, button/checkbox clicks, on-screen typing) and any errors that were made. Errors are defined as actions that prevented the user from completing a task in the most efficient manner and included entering data into the wrong field, selecting the wrong choice, clicking on something unclickable, and failing to take an important action.

Two research personnel were present for each participant. The first researcher (the "interviewer") was responsible for introducing the study, administering the surveys and interview, eliciting and writing down participants' verbal feedback, and writing down participants' nonverbal body language (e.g. furrowed brow, yawning). The second researcher (the "observer") was responsible for writing down all of the participant's interactions with the website. At the end of the session, participants were thanked for their time and given a US$35 gift card.

Post-website visit. Immediately following their visit, participants completed a brief *post-visit survey* where they used a 5-point Likert-type scale to rate whether they would want to return to the website for another visit and whether they would recommend the website to a friend. Similar global metrics of experience have been found to be very effective at summarizing the user experience.[17] Participants then completed the *Website Analysis and Measurement Inventory* (*WAMMI*),[39] which is a commonly used measure of usability where participants rate their level of agreement with 20 statements on a 5-point Likert-type scale. The WAMMI was developed using latent variable analysis, has high reliability, and reports standardized scores (e.g. 50 = average; 100 = perfect) for five themes (Attractiveness, Controllability, Efficacy, Helpfulness, and Learnability) based on a reference database of websites. We chose to use the WAMMI for its multi-factor model and ability to compare scores with normative data. Finally, participants participated in a short *post-visit semi-structured interview* (see Table 1) where they were asked for their opinions about the website, and their responses were recorded.

Qualitative analysis. The videotaped usability sessions were transcribed by research staff for all verbal exchanges, including responses to the post-visit semi-structured interview, and behavioral observations. Two PhD level researchers conducted a qualitative analysis over 3 months to identify themes in users' reported website experience. Constructivist grounded theory's line-by-line analysis[40] was employed whereby primary coding went line-by-line through the text and identified thick descriptor themes stated by the participants. Secondary coding gave a second pass of the transcripts and videos, reviewing all initial themes for accuracy in application and ensuring uniqueness and non-overlap of themes. At this point, themes that were not present for a significant portion of the sample (three cases) were reviewed, merged when applicable, and discarded otherwise. A third and final coding was conducted to impose hierarchy to the remaining themes, whereby themes that hung together in coding and/or overarching construct were grouped together into parent nodes. Issues of disagreement were addressed by consensus agreement. NVivo-9[41] was used to record and refine the qualitative themes. Users' WAMMI responses were imported into NVivo. Matrix analysis from these mixed-method data was conducted with qualitative themes by quantitative WAMMI scores. Triangulation[42] of these mixed-method results indicated high co-occurrence and similarity of conclusions across both qualitative and quantitative data, suggesting validity to the conclusions made in the qualitative analyses.

Table 1. Questions asked during the post-visit semi-structured interview.

1. Being as honest as possible, would you want to return to the website for another visit?
2. If this website were online, how likely is that you would actually return to the website for another visit?
3. Would you recommend this website to a friend?
4. How helpful was the information on coping with depression?
5. What did you think about the section of the website where you picked activities and scheduled when to do them?
6. On the website, you were given a list of potential activities to put into the planner. Are there any additional activities that you would add to the list?
7. Some of the web pages displayed text next to different faces. What did you think when you saw these types of pages?
8. What did you think about the cartoon characters on the website?
9. Do you think the website is geared more toward a specific gender?
10. How likely is it that you would want to print out any of the web pages?
11. What did you think of the website's color scheme?
12. Do you have any other suggestions for improving the website?
13. You just saw a demonstration about what you can do on the website if you returned for a second visit. What did you like and dislike about the return visit?
14. Do you have any suggestions on how we could improve the return visit?

WAMMI results

The WAMMI report identified general strengths and weaknesses of the mood module (see Table 2). All WAMMI scores are standardized scores reported as percentile ranks. The WAMMI analysis found a Global Usability Score (GUS) of 66.09 ($SD = 18.85$), indicating an above-average user experience overall.

Attractiveness. Attractiveness refers to a website's ability to be appealing both visually and content-wise to the users. The website received a WAMMI Attractiveness score of 58.4, indicating an above-average Attractiveness level. Of the participants who met the clinical cutoff criteria for depressive symptoms on the CES-D, 85 percent strongly or slightly agreed with the statement of "This website has much that is of interest to me" while 53 percent of participants who did not meet the criteria agreed with this statement.

Controllability. Controllability refers to the ability of the users to navigate easily around the website and perform the actions that they want using the interface. The website received a WAMMI Controllability mean of 66.59 ($SD = 22.77$), indicating above-average Controllability.

Efficiency. Efficiency refers to the users' perception of being able to use the website in an economical matter, at a reasonable speed, and without wasteful effort. The website received a WAMMI Efficacy mean of 71.45 ($SD = 20.05$), indicating a high level of efficiency.

Helpfulness. Helpfulness refers to the ability of the website to meet the users' expectations and provide a logical and relevant experience. The website received a WAMMI Helpfulness mean of 69.77 ($SD = 23.16$), indicating a high level of Helpfulness.

Learnability. Learnability refers to the ability for users to comprehend how to use the website and understand its content from the start. The website received a WAMMI Learnability mean of 65.8 ($SD = 21.9$), indicating above-average Learnability.

Table 2. Website Analysis and Measurement Inventory (WAMMI) results.

	Strongly agree	Slightly agree	Neutral	Slightly disagree	Strongly disagree
Attractiveness					
This website has much that is of interest to me.	32%	32%	14%	18%	5%
The pages on this website are very attractive.	50%	5%	23%	14%	9%
I do not like using this website.	5%	0%	18%	32%	45%
This website has some annoying features.	5%	14%	9%	27%	45%
Controllability					
It is difficult to move around this website.	0%	0%	9%	18%	73%
I feel in control when I am using this website.	45%	27%	14%	5%	9%
I can easily contact the people I want on this website.	18%	14%	41%	14%	14%
Remembering where I am on this website is difficult.	0%	9%	9%	36%	45%
Efficiency					
I can quickly find what I want on this website.	64%	14%	14%	9%	0%
This website is too slow.	0%	0%	5%	23%	73%
I feel efficient when I am using this website.	18%	36%	14%	14%	18%
Using this website is a waste of time.	0%	0%	5%	23%	73%
Helpfulness					
This website seems logical to me.	64%	23%	5%	9%	0%
This website helps me find what I am looking for.	50%	23%	18%	5%	5%
It is difficult to tell if this website has what I want.	5%	0%	14%	41%	41%
I get what I expect when I click on things on this website.	41%	41%	9%	0%	9%
Learnability					
This website needs more introductory explanations.	14%	18%	5%	27%	36%
Learning to find my way around this website is a problem.	5%	0%	14%	27%	55%
Using this website for the first time is easy.	64%	23%	9%	0%	5%
Everything on this website is easy to understand.	55%	36%	9%	0%	0%

Qualitative analysis results

A qualitative analysis of the usability sessions, including the post-visit interview, identified several main themes of the user experience as well as 120 unique and specific usability issues. The most common themes and usability issues identified by the qualitative analysis are described below, organized by WAMMI categories.

Attractiveness. Most participants (83%) expressed a positive response to the website's use of graphics and cartoons. Several of the web pages featured hand-drawn characters engaged in dialogue to convey psychoeducation about depression. Over half of participants (58%) expressed liking the use of these cartoon dialogues to convey information. A few participants said they disliked specific graphics, for example, a cartoon of an eccentric-looking "weird" and "scary" scientist (13%) who was teaching information about depression. Regarding the color scheme, most participants (67%) suggested incorporating a greater variety of colors into the website design.

Many participants (42%) commented on how the website's content was applicable to a wide variety of people. Most participants (79%) believed that the website had equal appeal to both

genders. However, some participants (38%) pointed out that the website's content was not applicable to them, personally, because they did not struggle with depression. Several participants (13%) commented regarding liking how the website was geared toward teenagers and discussed depression from a teenager's point of view. However, a small percentage of participants (13%) commented that the use of cartoon graphics on the website may reduce its appeal to older teenagers.

Participants offered many comments regarding which features of the mood module were most interesting and appealing. Several participants (21%) commented that they liked how the website provided a personalized experience for each user. For example, the website allows users to select navigation options based on their interests, offers interactive quizzes and feedback, and takes users through the process of creating their own personal behavioral activation plan. Several participants (25%) commented that they liked the website's use of videos, particularly because it reduced the amount of required reading. Another popular feature was the website's use of humor (33%).

Research staff noted that another usability issue was that the website was optimized for specific browsers, and thus appeared differently on the screen depending on the browser. For example, the text and videos appeared off-center for certain browsers, which decreased the attractiveness of the website for those users.

Controllability. The depression module has a basic linear structure, with participants progressing through the pages in pre-determined order. However, there are also several points when users are given the option to learn additional details about the subject or skip to the next section. Several participants (17%) commented about how they liked being offered navigation options. The most common usability issue observed under the Controllability theme was that seven participants (29%) had one or more instances where they tried to click a small checkbox but missed and clicked outside the checkbox. Another usability issue was that four participants (17%) had difficulty getting the video control buttons (e.g. pause, play) to work (e.g. nothing would happen after buttons were clicked).

Efficiency. Efficiency was observed to be affected by the browser that the patient used. On certain browsers, the text ran off the right side of the page, forcing users to scroll to the right to finish reading each line. In addition, these users had to engage in extra downward scrolling during the video quizzes because the layout was not optimized on the screen. As the video narrator stated the question and the answer options, users had to scroll downward to view the answer options, which meant they could not watch the video and view the answer options simultaneously. In addition, six participants (25%) commented on how some of the psychoeducation pages were repetitious. They suggested that the information could have been communicated more concisely on a fewer number of screens.

Helpfulness. Almost all participants (96%) commented on the helpfulness of the content of the website. In particular, many participants (42%) mentioned that the Activities Planner was helpful. Several participants (17%) expressed positive comments for how feedback (e.g. correct answers and explanations) was provided after selecting responses to quizzes. While going through the website, many participants offered comments on how the material they were reading led to a gain in knowledge (67%), made sense (42%), was credible (21%), or that they agreed with the content. However, eight participants (33%) did express disagreement with the content on one or more of the pages.

There were several usability issues where participants' expectations were not congruent with the website's offerings. For example, a number of participants (71%) had one or more instances

where they clicked on a still image or non-interactive text in anticipation of an interactive experience. As another example of incongruence with expectations, after completing the first video quiz, participants were taken to a page with their quiz results; however, 25 percent of participants said that they did not realize that their responses were being evaluated. In addition, three participants (13%) expressed how they would not choose any of the answer options on some of the video quiz questions. Another example of incongruence is that three participants (13%) expressed disagreement with the results of their mood assessment, which offered feedback on the severity of their depressive symptoms.

Errors in validation procedures also were detected. It was observed that 29 percent of participants did not select a response on a web page when one was prompted. In some cases, validation logic then displayed a pop-up message explaining that the participant was required to select a response. However, in other cases, participants were permitted to continue through the module without being prompted to enter the missing information.

Learnability. Most participants (75%) had one or more instances where they were confused about how to properly use the website or about what message the text conveyed. The reasons for the confusion were primarily due to not understanding specific text or due to lack of instructions displayed on the web page. Four participants (17%) had difficulty understanding or hearing what was said in one or more videos. In addition, 42% had one or more instances where they were confused about how a specific graphic was related to the content of the page.

This analysis assisted us in identifying web content that was clear and concise, as well as web content that created confusion for some users. For example, on a web page where participants could roll their mouse over specific emotion words to see a cartoon face representing that emotion, about one in four participants (29%) said that they were unsure what was required of them on that page. On another web page, 25 percent of participants were confused about a specific analogy that was used to illustrate a concept on the site. Across several web pages, although many participants liked the use of cartoon dialogues to display information, four participants (17%) did not recognize that the content on some of the screens was intended to represent dialogue between the characters. Four (17%) participants also expressed confusion about the purpose of certain images on the site (e.g. basketball and basketball net).

Some participants did not use the website exactly as the developers had intended. Moderators observed that 25 percent of participants obviously did not read the text on one or more pages. For some of these participants, skipping this text contributed to their confusion about what to do on certain web pages. On a specific web page that has participants complete a short psychoeducation quiz, four participants (17%) did not click the "Grade Me" button to see their results. Instead, after completing the quiz, they immediately clicked the "Next" button, which brought them to a new web page without receiving any feedback on the quiz. An additional 17 percent of participants who did click the "Grade Me" button chose not to scroll back up to see which questions were marked as wrong, and instead just clicked the "Next" button.

Post-visit survey results

On the brief post-visit survey, participants were asked whether they would want to return to the website for another visit. Of the participants who met the clinical cutoff for depression symptoms, five (71%) responded that they definitely or possibly would and two (29%) responded that they were unlikely to return. Of the non-depressed participants, nine (56%) responded that they definitely or possibly would, three (19%) were unsure, and four (25%) responded that they were unlikely to return. When asked if they would recommend the website to a friend, 71 percent of the

depressed participants said yes and 63 percent of the non-depressed patients said yes. The rest were unsure (14% depressed; 25% non-depressed) or said no (14% depressed; 13% non-depressed).

Discussion

Remotely delivered interventions, such as self-help websites or mobile applications, have the potential to increase access to evidence-based treatments for disaster-affected families. Given the lack of mental health resources post-disaster, these remotely delivered interventions could be integrated into a stepped-care approach to increase the reach and accelerate the timing of mental health service delivery. The research in the efficacy and utility of such web-based interventions is promising. However, the development of such applications requires a multi-stage process with collaboration between team members and familiarity with "best practices" of application development. This article described the development process and design considerations for a web-based, self-help intervention for disaster-affected adolescents and their parents. Careful consideration of site design, interactivity, child development, privacy concerns, security issues, and user response were key components to successful development. To evaluate user response, we conducted a formal usability study, and are also currently conducting a large-scale randomized controlled trial with disaster-affected families.

This article demonstrates how a formal usability evaluation can provide comprehensive information regarding target users' responses to a self-help mental health application. The usability study identified the strengths and weaknesses of the Mood module of the BBN application, including the features that were most liked and the usability issues that were most prevalent or problematic. Furthermore, feedback was collected in real-time, as adolescents used the application, which increased the accuracy and comprehensiveness of the collected feedback. There was consistency between much of the qualitative and quantitative results, suggesting validity of the qualitative impressions. The results of the usability analysis will be used to guide revisions to the website in order to improve its usability and efficacy for adolescents and their families. A weakness of the usability study is that it was based on a single session. Additional useful information could be obtained by analyzing the usability of users' return visits and utilization of the website features that monitor progress.

Mental health professionals who are unfamiliar with the application development process may not have a complete awareness of the steps that can be taken during the development process to maximize the quality of an intervention. Frequently, users will respond to application interfaces in ways that were not initially predicted; thus, the testing, evaluation, and revision process is just as important as the initial creation. Applications often must evolve through several evaluation phases in order to become a polished and effective product. It is ideal to conduct usability testing at multiple stages in the development process, with multiple iterations. Therefore, mental health application developers are advised to work into their budget and timeline this process of testing the website with target users, obtaining their feedback, and making revisions to the design and content.

Conducting a usability study involves several challenges. Projects may have limited resources, finances, and timelines. Usability testing is time consuming and can be costly, particularly if testing indicates that extensive revision to the application is needed. However, there are numerous benefits of usability testing to the application development process—it has been indicated to have substantial impact on users' experience and likely on the large cost–benefit ratio of the product. As an example, our study utilized both qualitative and quantitative analysis to identify themes and usability issues. Although the qualitative analysis produced more in-depth and specific data than quantitative analysis, the quantitative and qualitative analyses came to many of the same global conclusions. Because careful qualitative analysis is time consuming and requires special expertise,

development groups may instead choose to identify broader usability issues through less time-intensive processes and follow up with formal qualitative approaches only on specific issues or portions that are problematic.

Another challenge involves eliciting detailed feedback from participants. There is the danger of participants displaying a leniency bias when offering feedback on an application due to social desirability and wishing to please the researcher. In cases where participants are reluctant to offer critical comments about the application, or rarely offer any comments at all, it can be helpful to (a) give a demonstration at the beginning to illustrate the kind of critical feedback that is useful, (b) verbally reinforce participants for providing critical comments, and (c) provide verbal or visual reminders to verbalize their thoughts while they use the website (e.g. "What is your reaction right now?"). Furthermore, participants who are representative of the target user group appear to provide more relevant feedback. Alternative approaches to interviewer probing, such as on-screen pop-out questions, may also alleviate some of these issues.

Third, identifying and prioritizing usability issues can be a challenging process. The number of usability issues that will arise will increase with the number of participants recruited in the usability study. In most cases, there likely will be financial or time limitations that prevent some of the usability issues from being corrected or addressed. Both content and programming development teams will then have to prioritize which usability issues are most important to the end-treatment product and agree on what changes are feasible to make in the next version of the application.

There are also additional methods of collecting usability metrics that mental health application developers may find relevant in the development of their application. A commonly used strategy is to give participants specific tasks to complete while using the application in order to collect metrics on task success rates, time to complete the task, and efficiency of completing the task (e.g. amount of effort as measured by mouse clicks and page views). However, Christensen et al.[3] have suggested that the relation between these measures and treatment outcome may be confounded by users' motivation for change. Additionally, their work suggests that for some web-intervention users, dose or duration is not requisite for behavioral change. Another approach could be to have participants use the application from their home (instead of in a laboratory setting) and provide written or audio-recorded feedback in real-time. Other behavioral metrics may be collected through the use of eye-tracking software to determine where a participant looks, how much time they spend looking at something specific, and how long it takes to notice something. Physiological metrics can be collected by measuring skin conductivity and heart rate to assess for stress and frustration levels as participants use specific parts of an application, but these metrics are heavily influenced by individual differences in base rates and reactivity and confounded by stress intentionally elicited by the intervention itself (i.e. trauma reminders/assessments, exposures). Each of these approaches has been found to have limitations and strengths, and therefore multi-methods are likely beneficial.[17]

In conclusion, we found the process of developing a web-based self-help application to be a challenging but feasible process. In addition, conducting a usability study was an extremely helpful method of obtaining information about aspects of the user experience that we otherwise would not have observed using traditional quantitative analysis. These results are being used to guide revisions to the self-help website for adolescents and their families. Our next step will then be to continue to evaluate and disseminate the intervention on a large-scale basis. Kerner and Hall[43] suggested that, in order for psychological interventions to gain real-world implementation, it is essential to relay evidence of the intervention's scientific efficacy to three main communities: (1) the scientific community, (2) the service provider community, and (3) the policy community. Consistent with this approach, we intend to disseminate efficacy findings to the scientific and disaster mental health communities via publication of peer-reviewed scientific articles

and presentation at relevant scientific conferences. Given that our target audience consists of disaster-affected adolescents and their parents, we plan to conduct additional research with these intervention materials in partnership with disaster response agencies, such as the American Red Cross and Office of the Assistant Secretary for Preparedness and Response. These partnerships were recently established, and we hope to evaluate these intervention materials more directly with the target population in future research. Our project team will continue to build on these existing partnerships and continue to establish collaborations and cross-communication with policy organizations and other relevant stakeholders.

Mental health professionals participating in the development and dissemination of an intervention that utilizes technology are encouraged to engage in further education on best practices for application development, evaluation, and dissemination. The importance of these best practices applies not only to self-help websites, but also to all other types of technologies, such as virtual reality interventions and mobile mental health applications for smartphones and tablets. As technology continues to advance and be made available in increasing numbers to the public, it can expected that the opportunities for disseminating efficacious interventions through these technologies will also expand. Well-designed usability studies and randomized controlled trials will be critical to the success of these interventions in improving clinical symptoms, reducing treatment barriers, and gaining widespread support from the general public and the scientific, service provider, and policy communities.

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