More than just tracking time: Complex measures of user engagement with an internet-based health promotion intervention

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ABSTRACT

Background: There has been a rise in internet-based health interventions without a concomitant focus on new methods to measure user engagement and its effect on outcomes. We describe current user tracking methods for internet-based health interventions and offer suggestions for improvement based on the design and pilot testing of healthMpowerment.org (HMP).

Methods: HMP is a multi-component online intervention for young Black men and transgender women who have sex with men (YBMSM/TW) to reduce risky sexual behaviors, promote healthy living and build social support. The intervention is non-directive, incorporates interactive features, and utilizes a point-based reward system. Fifteen YBMSM/TW (age 20–30) participated in a one-month pilot study to test the usability and efficacy of HMP. Engagement with the intervention was tracked using a customized data capture system and validated with Google Analytics. Usage was measured in time spent (total and across sections) and points earned.

Results: Average total time spent on HMP was five hours per person (range 0–13). Total time spent was correlated with total points earned and overall site satisfaction.

Conclusion: Measuring engagement in internet-based interventions is crucial to determining efficacy. Multiple methods of tracking helped derive more comprehensive user profiles. Results highlighted the limitations of measures to capture user activity and the elusiveness of the concept of engagement.

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1. Background and significance

Internet-based health promotion interventions that can be accessed via computer and mobile devices (i.e. tablets, smartphones) are increasingly used to address a range of health behaviors [3,27]. Widespread access to these technologies [8] facilitates the rapid dissemination and easy adoption of internet-enabled mobile interventions [23] without significant need for specialized expertise or training [24]. Compared to traditional in-person interventions, internet-enabled mobile interventions can be more cost-effective [19,24,26] and allow for a high level of tailoring and interactive content [18,20].

Despite growing enthusiasm surrounding the use of internet-enabled mobile interventions, little is known about how to measure and evaluate meaningful user engagement [6]. For in-person interventions, engagement is typically measured by participant retention rates [10], duration of exposure, and complexity of the intervention [16]. Internet-based interventions that include multiple sessions have been shown to be more efficacious than single-session interventions [4,16,24]. However, exposure measures are not necessarily accurate proxies for components of engagement such as participants' actual levels of attention, focus, or interactivity during intervention sessions [7].

Popular tools such as Google Analytics allow the collection of basic site usage data such as page views, average time spent on a page, and whether visitors are new or returning (based on IP addresses). Much of this data is presented in summary statistics rather than for individual users. Consequently, drawing conclusions on outcomes from individual use of an intervention is not possible without additional measures of activity. Furthermore,

relying solely on user activity defined as time spent and areas of the intervention visited is unlikely to sufficiently capture engagement [7].

In order to determine optimal delivery and dosage for internet-enabled mobile interventions, new ways to understand and evaluate user engagement are needed. As compared to earlier administration of technology-based interventions that were often highly-structured and conducted in office or clinic-based settings, newer internet-enabled mobile interventions can now be delivered with minimal external supervision [24]. Within the intervention, user direction and guidance also varies widely. For example, some internet-enabled interventions guide users from one part of the site to the next with limited ability to view other areas of the site until each prior activity has been completed [28]. Other interventions provide more unstructured access, allowing participants to determine if and when they access the site, what sections they visit, and for how long [23]. While this approach offers users more flexibility and tailoring, it also further complicates measures of user engagement. For example, users commonly multitask while online by keeping multiple webpages open at once or engaging in other activities (e.g. watching TV, eating). Keeping the user engaged in the online intervention and measuring what constitutes meaningful engagement becomes difficult when providing participants the freedom to access an intervention as much or as little as they want.

This analysis explores an approach to enhance and complement current methods to measure user activity in web-based interventions. To achieve this goal, we use an example of how measurement metrics might be applied to a complex, multi-component intervention through a case study of healthMpowerment.org (HMP), an internet-based health intervention for young Black men and transgender women who have sex with men (YBMSM/TW) in North Carolina (NC) [11,12,13]. By establishing rigorous, multiple measurement metrics for a complex, user-driven intervention, we also create a system of capturing a nuanced picture of intervention exposure that can be used to better understand what types and levels of intervention engagement may be predictive of the target intervention outcome(s).

2. Materials and methods

2.1. Intervention development: healthMpowerment.org (HMP)

HMP is a mobile phone-optimized, online intervention for YBMSM/TW aged 18–30 that is designed to reduce high-risk sexual behaviors and promote healthy living. HMP aims to build community by creating online social networks that encourage positive norms and facilitate supportive relationships among HIV-positive and HIV-negative YBMSM/TW.

HMP was developed with attention to best practices in facilitating behavior change [11,13,22] guided by the Institute of Medicine's (IOM) Integrated Behavioral Model (IBM), which incorporates constructs from the Theory of Planned Behavior and Social Cognitive Theory [1]. The features and content of the HMP intervention were developed to address all the major constructs of the IBM (Fig. 1 and Table 1).

In brief, the HMP model conceptualizes high-risk sexual behaviors to be influenced by intentions to engage in particular behaviors, attitudes about the behaviors, perceived behavioral norms, perceived self-efficacy to engage in a behavior, skills and abilities, and environmental constraints.

The HMP website was also intentionally designed to incorporate multiple features to encourage a high level of end-user engagement – here defined as a user's interaction and involvement with the website. It is critical for users to engage with the HMP website in order to experience the intervention; without
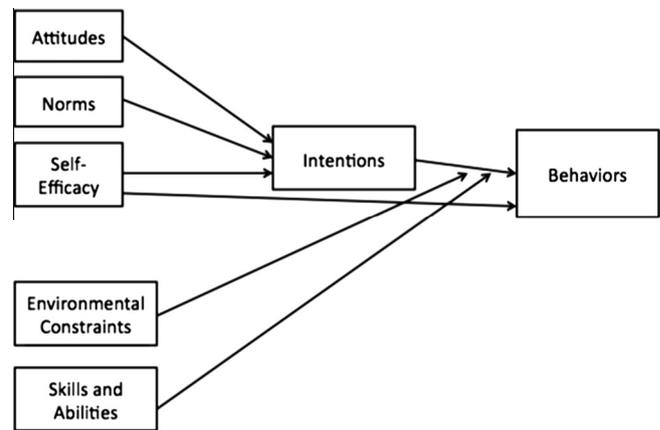

Fig. 1. HMP adaptation of the Integrated Behavioral Model.

engagement, we cannot measure the efficacy of the intervention itself. To encourage high user engagement with HMP, in the intervention design we employed best practices in health communication theory that focus on crafting messages to draw attention and increase comprehension and response. This includes the use of gain-framed messages, i.e. ensuring that users perceive a gain from performing a suggested action or behavior rather than a loss-frame; and the use of elaboration likelihood, designing messages that help to make an idea more relevant to a user [17,25]. We also incorporated gamification features in the design of the website (e.g. quizzes, self-assessments, competitions, and rewards) and designed a site-wide point-based system (described in more detail below) that rewards users for each activity they perform on the intervention website.

2.2. Study procedures

From February to March 2013, 15 YBMSM/TW in central NC participated in a one-month pilot trial. The purpose of the pilot trial was to test the usability, relevance, and preliminary efficacy of HMP as well as the backend data capture system, and to identify any features or aspects of the intervention website that needed revision or improvement prior to conducting a state-wide randomized controlled trial (RCT). The Institutional Review Board of the University of North Carolina at Chapel Hill approved all aspects of this study.

2.2.1. Recruitment

To recruit a diverse sample, study announcements were posted in a variety of settings including an infectious disease clinic, health department clinics, a college campus, and online through Craigslist and Facebook. Interested individuals were screened by phone to determine eligibility (age 18–30; born biologically male; self-identify as Black or African American; currently reside in NC; self-report sex with another man in their lifetime; and, currently use a mobile device to text, browse the internet, or use phone apps). Participants who met the inclusion criteria were scheduled for an in-person appointment.

2.2.2. Intervention overview

Participants were asked to spend at least one hour on the HMP site per week for four consecutive weeks. This amount of time was selected as the minimum "intervention dose" to approximate a typical in-person counseling or educational intervention. Furthermore, this requirement aimed to create a stronger sense of an online community among participants and increase users' opportunities to explore and test multiple areas of the site. Notably,

Table 1
HMP website sections and Reputation Points.

HMP intervention components				Point system		User engagement	
Section	Section purpose	Intervention(s)	Theoretical constructs[a]	Points earned by	Points awarded	Total visits[b]	Total points earned[b]
Home screen	Log on	Incentivize engagement		Log on with username and password	20[c]	330	6120
Talk to Someone	Health-related questions answered by a doctor	• Gain new knowledge • Combat stigma • Establish positive social norms	• Self-efficacy • Skills and abilities • Environmental constraints	Submit a question	10	6	30
House of Mpowerment	Knowledge quiz application	• Assess current knowledge • Gain new knowledge	• Self-efficacy • Skills and abilities	Complete a quiz level Perfect score on a level Perfect score on all 4 levels Perfect score in all categories	10 25 50 100	250	4320
Thinking it through	Decision-making game	• Assess behavior	• Attitudes • Norms[d] • Self-efficacy	Complete a cycle	10	Not captured[e]	Not captured[e]
Journal	Private diaries (medical history; hookups; free text)	• Encourage health maintenance • Assess behavior	• Self-efficacy	Record an entry	10	15	150
Local flavor	Reviews of local businesses and safer-sex products	• Build community	• Norms[d]	Submit a review Add a new business	5 3	5	21
Local scene	Community calendar	• Build community	• Norms[d]	Submit an event	5	5	5
Getting real	Multi-media user submissions	• Build community • Establish positive social norms	• Attitudes&Norms[d]	Add content Comment on another user's content "Like" a submission	25 5 1	22	244
Forum	Message board	• Build community • Establish positive social norms • Gain new knowledge	• Attitudes&Norms[d]	Contribute to conversation	10	110	1100

[a] From the Institute of Medicine's integrated model adapted for "new media".
[b] Total for this section for all users over the 4 week study period. A visit to a page did not necessarily result in points earned.
[c] One hundred total possible points per day.
[d] Virtual communities provide social and peer support based on mutual counseling and sharing of information and experiences.
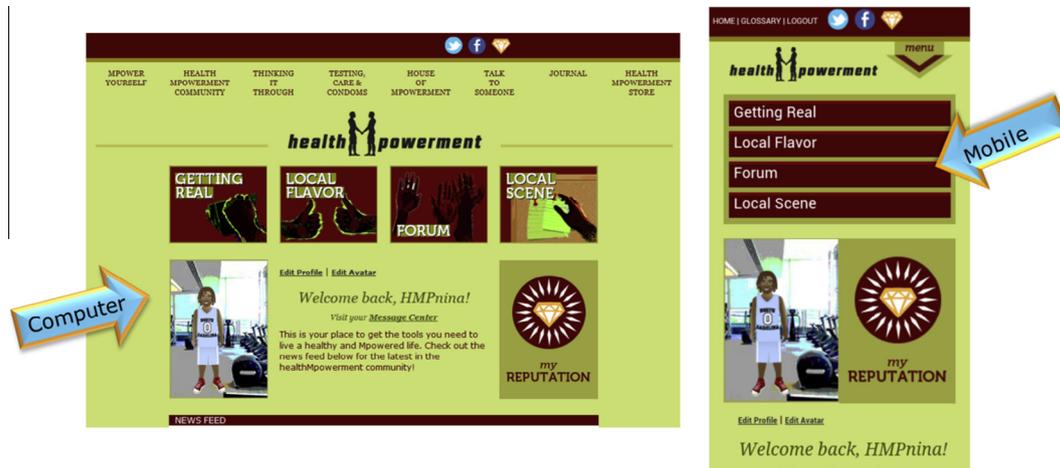[e] Not captured due to limitations in internal user tracking database.

Fig. 2. Screenshot of Homepage from desktop and mobile.

HMP is entirely user-driven; participants could visit any part of the site they wanted, when they wanted, on any internet-enabled devices they had available (e.g. laptop, mobile phone, tablet) (See Fig. 2). The components of the site included an interactive "Community" section with four elements: The "Forum," "Getting Real," "Local Flavor," and "Local Scene." In the "Forum," users could have discussions with each other and the study team on pre-determined topics including Getting Tested, Safer Sex, Dating and Relationships, and Healthy Living; Getting Real offered a space for users to upload their own content in image, video, audio, or text format; Local Flavor was a directory of local businesses that users could review; and Local Scene was an events calendar users could update. Elsewhere on the site was another opportunity for interaction in "Talk to Someone," a message board where users could submit health-related questions to a board-certified doctor who would respond within 24 h. The questions and responses were then posted anonymously so that all other users could review them. Additional components of the site included informational articles and videos, health behavior and disease risk screeners and quizzes, a GPS based HIV test site locator, private journals, and a decision-making game in the style of "Choose Your Own Adventure" books that models behavioral decision-making skills around drug and alcohol use and sex. For a list of all site sections, see Table 1.

During the four-week pilot trial, the study team communicated with participants through email and short message service (SMS) text messaging (depending on participant preference) as well as using messages in a private "Message Center" found on the home page of HMP. The messages consisted of log-in reminders each Monday; highlights of different areas of the site mid-week; notes to have a fun and safe weekend on Fridays; and intermittent personalized messages of encouragement to users who had not logged on to the site in over five days or who were not meeting their one hour per week minimum site activity quota. These intentional communications were also designed to prompt and maintain user engagement with the intervention over the course of the four-week study. Additional communication with participants (by phone, email and SMS) included support for technical difficulties with the site and scheduling of a four-week follow-up appointment.

2.2.3. Study procedures
2.2.3.1. Baseline visit. The baseline appointment lasted approximately 90 min consisting of informed consent, a computer-assisted survey using Qualtrics software (Qualtrics, Provo, UT), a tour of the website administered by the project's research assis-

tant, and the creation of a unique username and password for the secure website.

2.2.3.2. Follow-up visit. Upon completion of the four-week intervention, participants attended a second in-person appointment lasting approximately 90 min and consisting of a similar computer-based survey and an in-depth, semi-structured interview with two members of the research team on their HMP usage experience. Both the baseline and follow-up in-person visits were conducted in a private room dedicated to the study.

2.2.3.3. Remuneration. Participants could receive up to $100 in gift card remuneration for study participation: $25 at baseline appointment, $25 at week four follow-up visit, and a $50 bonus for spending at least one hour per week for all four weeks using HMP. In addition, participants earned points for all activity on the site (see Table 1 and Measures section below) which they could spend in the HMP store to "purchase" items including pens, condom wallets with condoms, mints, lip balm, water bottles, sweatshirts, underwear, and messenger bags.

2.2.4. Study measures
2.2.4.1. Website utilization. Participant activity on the website was tracked through a separate, password-protected administrative portal. This portal featured four main components; user tools, site use, site tools, and community. User management and tracking components were located mainly in user tools and site use. Administrators and study staff used the portal to view site usage per user, user role, date, page, and/or user action. A timestamp captured every recorded user interaction, such as every time a user logs in, logs out, modifies their profile, views their site messages, views an article (along with the name of the article viewed), completes a quiz, views the page to locate testing and care resources, takes a quiz, set or edits a goal, adds information into the health journal, submits a question to the doctor, or uses any of the community features. By tracking the users' interactions, the study team was able to determine the number of people that visited the site during a specific timeframe, last page accessed during a visit, what a user did when they visited, what path they took through the site, and how long they stayed logged in.

Total intervention exposure time per individual was determined by adding the time between each log-in timestamp and the recorded time of the user's final page click within each usage session. An automated log-out was programmed to occur after 10 min of inactivity.

This usage data was supplemented with tracking statistics from Google Analytics, which was integrated into the HMP by generating a tracking code snippet that was added to each page of the website. Google Analytics reports captured aggregate data on page views; new versus returning visitors; hardware devices, browsers, and operating systems used to access the site; and average time spent on the site and its pages. Google Analytics also provided the ability to run site usage reports excluding activity from IP addresses belonging to study team members.

An additional layer of user engagement tracking was applied through a detailed system of HMP Reputation Points which were awarded for all on-site participant activities and provided a quick way to gauge a user's overall activity on the site. The points awarded system used a 1–100-point scale that assigned point values to reflect the estimated level of engagement needed to complete the activity (e.g. getting a perfect score on a quiz level received more points than completing a quiz level with errors – note that quizzes could be taken multiple times) as well as type of engagement (e.g. more "active" activities such as adding a new post received more points than "passive" activities such as "liking" someone else's post). Participation with the intervention that was considered more "active" (such as posting to the Forum) earned more Reputation Points, while more "passive" actions (such as reading an informational article), received fewer points. As participants earned points, they could advance through four status levels to track their accumulated usage of the site. Specific Reputation Point values for all activities are reported in Table 1.

2.2.4.2. Quantitative survey. The four-week follow-up survey included questions about HMP usage and satisfaction with the site and its components. Satisfaction questions covered several domains of usability and engagement, (e.g. "the information on the site met my needs," "the site was easy to use," and "I would be likely to recommend this site to someone else") and participants answered using a 4-point Likert-type scale (Strongly Agree, Agree, Disagree, Strongly Disagree).

2.2.4.3. Qualitative exit interview. The qualitative exit interview consisted of questions about website and device usage, participants' favorite and least favorite sections of the website, thoughts on the language and imagery used, and participant motivation for using the site.

The main study measurements and outcomes for sexual risk behaviors, social support, social isolation and depressive symptoms [12] and qualitative assessment of HMP [21] are reported elsewhere.

2.2.5. Analysis

All HMP site user activity was exported from the administrative portal and Google Analytics into Excel. Composite measures were then calculated for usage of each section of HMP and the overall site for point totals and time spent per: log-in session, day, week,
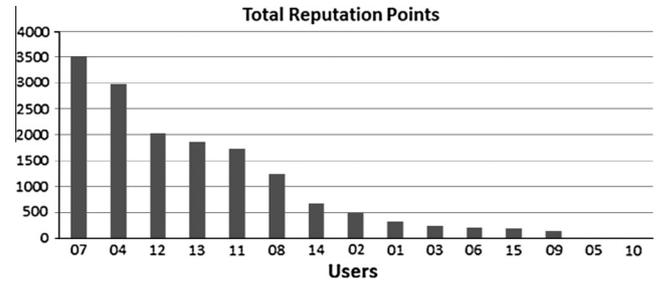

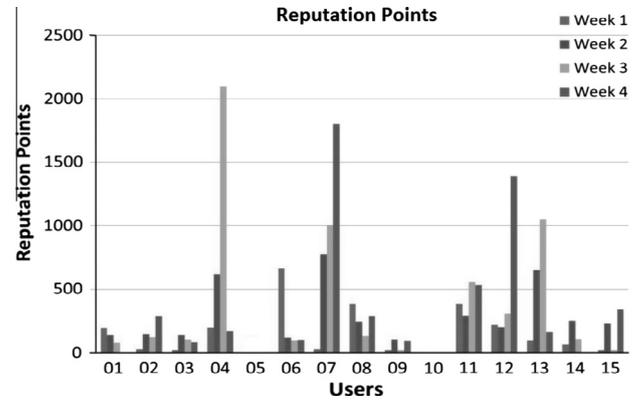**Fig. 4.** Total Reputation Points earned by users.

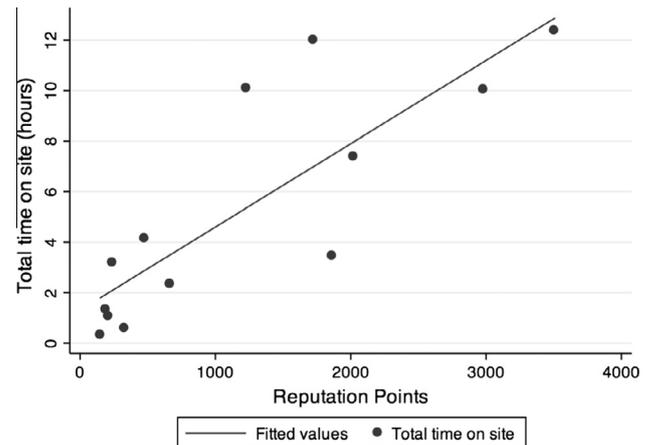**Fig. 5.** Reputation Points earned by users each week.

Fig. 6. Correlation between time spent on site and Reputation Points earned.

and four week total. In addition, overall site satisfaction was calculated by summing scores of all site satisfaction items. Pearson product-moment correlation coefficients were calculated to examine correlations between total time spent on site and point totals and total time spent on site and overall site satisfaction.

3. Results

3.1. Demographics

Participants ranged in age from 20 to 30 years old with a mean age of 26. In the six months prior to completing the baseline survey, the majority owned smartphones (13/15); sent or received texts (14/15), downloaded and/or used apps (13/15); used Facebook (10/15); and regularly searched for sex partners online
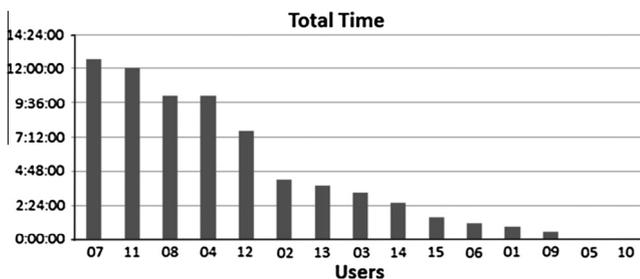

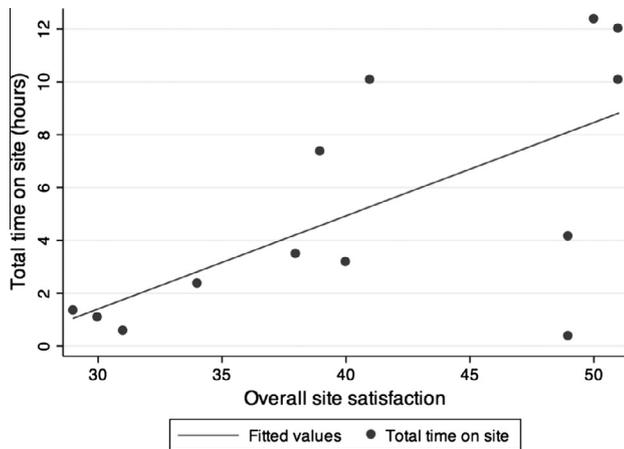**Fig. 3.** Total time spent on intervention site by users.

Fig. 7. Correlation between time spent on site and overall site satisfaction.

(14/15). The majority of participants had used technology to search for health-related information (9/10), and many had searched specifically for information on HIV or other sexually transmitted diseases (7/10). Five participants had used mobile apps to track health behaviors, including fitness, exercise, and diet.

3.2. Engagement

3.2.1. Individual activity

The average total time spent on HMP during the pilot trial was five hours per person (range 0–13 h, Fig. 3), and the average user earned 1040 Reputation Points (range 0–3500, Fig. 4). Total time spent on the site was strongly correlated with number of Reputation Points earned ($r = 0.83$; $p < .01$) and overall site satisfaction ($r = 0.65$; $p < .05$) (Fig. 6). Pearson product-moment correlation coefficients were calculated to examine correlations between total time spent on site and point totals and total time spent on site and overall site satisfaction using Stata version 12.1.

Two of the 15 participants (users 05 and 10) did not log on to HMP during the four-week trial. One had initial technical

difficulties with the log-in screen and became discouraged for the remainder of the pilot, while the other reported he was too busy to participate. The other 13 participants varied in activity level (measured by time spent on the intervention and Reputation Points earned), with the most frequent users spending an average of about three hours on the site during each week of the trial (see Fig. 5). Nine of the participants were active on the site for at least one hour per week.

Additionally, participants who spent more time on the site reported more satisfaction with the intervention in their follow-up surveys (Fig. 7). Excluding the two participants who did not use the site at all, the average time spent on the site among those who answered "Agree" or "Strongly Agree" to all 17 satisfaction questions ($n = 9$ participants) was 7 h and 35 min as compared to an average of 3 h and 18 min among those who responded "Disagree" or "Strongly Disagree" to any of the 17 questions ($n = 6$ participants) (Table 3).

3.2.2. Aggregate activity

According to Google Analytics and built-in user activity tracking on the site itself, HMP received 544 visits and 70 h of total user engagement over the course of four weeks. On average, 20 pages were viewed per visit; and the average visit lasted nine minutes and 21 s. Excluding the two participants that did not log in at all, there were approximately 25 log-ins per user over the course of the trial.

The addition of the data on Reputation Point earnings added a layer of reporting that expanded on user activity and types of intervention engagement. For example, User 08 logged into the website a total of 24 times (average), but spent over 10 h on the site throughout the course of the pilot (a great deal longer than average). Looking at Reputation Point earnings, we see that User 08 earned 1232 Reputation Points (just above average). Comparatively, User 04 spent the same amount of time on the site, logged in 39 times, and earned 2980 Reputation Points. Thus looking only at time spent on the site, Users 04 and 08 are similar; however, the Reputation Points show how their engagement profiles may in fact be meaningfully different.

Table 2
Demographics and usage profiles of HMP pilot participants.

User	Age	Gender ID	Sexual ID	Sex with (men only, both men and women)	HIV status	Total # log-ins	Total time spent (hh:mm)	Total Reputation Points earned	Site satisfaction (0–51)[a]	Area of site where most time spent[b]
01	29	Man	Bisexual	Men and women	Positive	15	00:57	424	31	Mpower Yourself
02	20	Man	Queer	Men and women	Negative	10	04:14	580	49	House of Mpowerment
03	30	Man	Bisexual	Men and women	Negative	7	03:17	344	40	Mpower Yourself
04	29	[*]	Other[c]	Men and women	Negative	39	10:06	3080	41	House of Mpowerment
05	23	Transitioning (MTF)	Gay	Men	Negative	0	00:00	0	51	N/A
06	23	[*]	Other	Men	Positive	6	01:09	313	30	Mpower Yourself
07	23	Man	Gay	Men	Negative	69	12:38	3500	50	House of Mpowerment
08	27	[*]	Other (MSM)	Men	Positive	24	10:08	1332	51	Forum
09	30	Transitioning (MTF)	Transgender	Men	Positive	6	00:35	250	49	Forum
10	23	Man	Gay	Men	Negative	0	00:00	0	39	N/A
11	26	Man	Bisexual	Men and women	Positive	66	12:01	1826	51	Forum
12	26	Man	Gay	Men	Positive	28	07:38	2125	39	House of Mpowerment
13	29	Man	Gay	Men	Positive	41	03:47	1959	38	Mpower Yourself
14	30	Man	Bisexual	Men and women	Positive	12	02:33	762	34	House of Mpowerment
15	25	Man	Gay	Men	Positive	6	01:33	291	29	Profile

[a] Site satisfaction score calculation: 0 = Strongly Disagree; 1 = Disagree; 2 = Agree; 3 = Strongly Agree. The follow-up survey asked 17 questions related to site satisfaction.
[b] Excludes home page (captured through log-ins).
[c] "Other" included free text field for participants to include how they identified (displayed in parentheses if completed).
[*] Participant skipped this question.

Table 3
Time spent on site in relation to site satisfaction responses in follow-up survey.

Responses	Time spent on site (hh:mm, rounded)		
	Range	Mean	Median
Participants who answered "agree" or "strongly agree" to all 17 site satisfaction questions (*n* = 9)	0:35–12:38	7:35	10:07
Participants who answered "disagree" or "strongly disagree" to any of the 17 site satisfaction questions (*n* = 6)	0:58–7:39	3:18	2:04

Additional analyses can be conducted to assess which sections of the intervention site were most appealing and engaging to participants. The sections of HMP that participants spent the most time using were "House of Mpowerment" and the "Forum." Nine of the 15 participants utilized the "House of Mpowerment" quiz section of the website accounting for 24% (250/1031) of all recorded activities in the built-in user tracking database. Eleven participants actively used the "Forum" resulting in 110 (10%) recorded activities of either starting a topic or responding to another user's post. In the exit interviews, "House of Mpowerment," the "Forum," and "Talk to Someone" received the most positive reviews. During the course of the pilot, three participants posted a total of six questions for the study doctor. A post with the most responses, "likes," and an active discussion among multiple participants could be considered more engaging than a post without any replies.

Users 04 and 08 provide a case study of those sorts of preferences within the intervention. For example, User 08 spent more time in the "Forum" than any other section both adding new topics to be discussed and responding in threads that other users started. Use of the "Forum" is an example of more social behavior on the website. The majority of User 04's points were earned in the "House of Mpowerment," which is an individual activity that does not involve interaction with other users.

4. Discussion

This pilot trial of an interactive, internet-based intervention is an ideal case study for developing new conceptualizations and measures of user exposure and engagement. While we found high levels of time spent on the HMP site, there are no scales or standard measures to assess the relevance or comparability of these measures with other similar internet-based interventions [2,5]. A participant might log-in multiple times a day and spend hours exploring the site, but this measure of time does not capture whether a participant is actually reading and comprehending information in the articles or simply clicking on them. One approach to address this limitation is to incorporate tailored as well as general knowledge quizzes and assessments to measure overall knowledge acquired and test material a participant was exposed to. Yet, these measures also require careful consideration: if a participant fails to acquire this knowledge, is it a result of the intervention component delivery mode, the user's engagement with this piece of the intervention, or some other factor?

In addition to measuring overall user engagement, another important issue for consideration is the level of structured versus unstructured activity that is built into internet-based interventions. A highly unstructured intervention that allows participants to browse website areas on their own without having to complete specified modules may be more desirable to participants but may also result in entire aspects of the intervention being overlooked, possibly resulting in lower intervention success [5]. Unstructured internet-based interventions are prone to similar issues that impact the use of mainstream websites. For example, according to a 2010 Microsoft study, researchers found that users stayed no longer than 70 s on 80% of the 205,873 webpages studied [14]. The study also found a browsing phenomenon called "negative

aging," which refers to users being less likely to abandon a site the longer they use it [14]. If negative aging similarly applies to internet-based interventions, initial guided use of a site or required completion of certain activities may help facilitate continued user engagement.

At the same time, overly burdensome engagement requirements could deter participants from embracing and exploring internet-based intervention sites in ways that are most useful or relevant to their needs. Following the importance of intervention tailoring, different participants may need exposure to different components of an intervention. The appeal of a non-directive intervention is that a participant can bypass an area of the site that they feel does not apply to them, potentially increasing engagement in more relevant areas for their needs. Furthermore, for some participants, more active engagement modes, such as taking quizzes, might provoke behavior change, while other users might be more receptive to passive activities like reading articles. For these reasons, HMP features a diverse offering of components which represents an advance over many existing internet-enabled mobile interventions that are more directive [24].

In order to keep a website engaging and able to compete with mainstream text messaging, games, and social and sexual networking apps, it is important to incorporate multiple methods of information delivery. For example, a website can have articles, games, quizzes, message boards, photo galleries, video clips, surveys, and more. The level of interactivity can vary from component to component and a significant design challenge involves finding the appropriate balance of static material and dynamic delivery [15] based on both the target user population and the target health behavior change outcome. With an internet-enabled mobile intervention such as HMP, this balance is a delicate and important one—not just to encourage engagement, but also to determine which modes and components can most effectively deliver the target intervention material and activities. Traditional health behavior change models can be used to guide this process, but they need to be adapted for the newly available technologies and social phenomena that the world of online social media and social networking are creating. See Table 1 for an illustration of how we approached the translation from theory to intervention for HMP.

Ultimately, having better measures of engagement with internet-enabled mobile interventions will help researchers determine associations between level of engagement and intensity of the intervention effect. Conducting the pilot trial as described above provided useful insight into which measures were adequate to capture user activity as well as limitations of our user tracking measures. This pilot trial also allowed for enhancements prior to conducting the full-scale randomized clinical trial of HMP. The weighted point system (Reputation points) tracked users' overall engagement with the site and awarded more points for use of active components of the site. This user-tracking feature proved to be an efficient way to quickly gauge individual user activity and no changes were made after the pilot trial. However, an area that required some modification involved the use of timestamps. In the pilot trial, we established general user activity logs with timestamps for log-ins and section access. In analyzing user activity from the pilot trial, we learned that it is important not only to apply timestamps to log-ins but ideally to every user action. Thus,

we have added timestamps to log-outs and time-outs so that users' dwell time in each section can be calculated to provide an overview of each participant's time spent on the site as well as detailed results of time spent on each section of the website. Finally, supplemental site usage programs such as Google Analytics provided an aggregate representation of general activity across all users. A limitation of such a program is that reports must be filtered to eliminate data generated by study staff site usage.

One limitation of this pilot trial is that participants were incentivized up to $50 explicitly to be engaged with the website, representing an artificial rather than organic approach to exploring engagement. This particular incentive structure will not be used for the randomized controlled trial of healthMpowerment. Additionally, study staff met with each participant personally at enrollment, which was intentionally done to boost engagement by creating a relationship and earning buy-in from participants at the beginning of the pilot [9]. A further complication is that the points system, which serves as one of our proposed measures for engagement, may also be an incentive to participants to engage more with the site. This limitation will be addressed to an extent in the current RCT of this study by comparing participants' engagement who are randomly assigned to the HMP intervention website with those who are randomly assigned to an information-only control website which includes the educational sections of HMP but none of the interactive, social support, or gamification features. Lastly, this pilot study intentionally utilized a small sample size and thus results may not be generalizable to larger populations. However, the sample was intentionally selected to represent the diversity of HMP's target end-users in age, sexual orientation and HIV status (Table 2). The statewide RCT of HMP now underway will enable application of the engagement measures among a more representative, fully-powered sample.

5. Conclusion

The growing field of internet-enabled mobile interventions needs new and more standardized measures to track and assess participant engagement at the individual and aggregate level. To begin to tackle this barrier through HMP we used multiple methods of tracking user activity to derive a comprehensive profile for each participant's use of the site. Detailed tracking provided a more intimate look at user interests and habits throughout the intervention. An award system for user engagement incentivized continued participation and served as another layer of individual user tracking.

Despite having metrics on time spent on HMP, there are no consensus guidelines currently available to truly measure engagement. Furthermore, defining site components as active and passive—and the importance and efficacy of each (individually and relative to each other)—is objective and undefined. In order to determine the effectiveness of these complex, emerging internet-based interventions, measurement tools and evaluation metrics need to be developed to incorporate the impact of a range of factors including-but not limited to-content, form, user engagement, and dosage. Non-directive internet-enabled mobile interventions (i.e. interventions where the user is free to choose how they engage with the platform rather than being required to complete a pre-defined program) pose particular challenges in this regard but also offer the promise of being highly attractive to the target users.

Measuring engagement in health interventions is a crucial component for determining efficacy. Regardless of intervention delivery mode, doing so requires significant forethought regarding how to define engagement, what to measure, and how to interpret this data. Internet-enabled mobile interventions have an

advantage in determining and creating these measures due to sophisticated systems that can be programmed to automatically track user activity. Additionally, the nature of the delivery invites participants to control their own dosage of the intervention, which can be a measure of engagement in itself.

Conflict of interest

The authors declare that there are no conflicts of interest.

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