Design of a Community-Engaged Health Informatics Platform with an Architecture of Participation

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Abstract

Community-engaged health informatics (CEHI) applies information technology and participatory approaches to improve the health of communities. Our objective was to translate the concept of CEHI into a usable and replicable informatics platform that will facilitate community-engaged practice and research. The setting is a diverse urban neighborhood in New York City. The methods included community asset mapping, stakeholder interviews, logic modeling, analysis of affordances in open-source tools, elicitation of use cases and requirements, and a survey of early adopters. Based on synthesis of data collected, GetHealthyHeights.org (GHH) was developed using open-source LAMP stack and Drupal content management software. Drupal’s organic groups module was used for novel participatory functionality, along with detailed user roles and permissions. Future work includes evaluation of GHH and its impact on agency and service networks. We plan to expand GHH with additional functionality to further support CEHI by combining informatics solutions with community engagement to improve health.

Introduction

In biomedical informatics, the level of community remains a fairly unexplored application domain. While public health informatics generally addresses population health, community-level engagement is rarely investigated from an informatics perspective. Community-based participatory approaches have rarely been applied in public health informatics. Meanwhile, there is increasing recognition that how people live in their communities is a major determinant of health. Recent healthcare policies in the U.S., such as patient-centered medical homes and population-based accountable care initiatives, are consistent with the idea of situating patients and health resources in communities. Academic medical centers, such as the Columbia University Medical Center in New York City where the present study is located, are moving towards the population health model required by the Affordable Care Act by recognizing the value of partnering with community stakeholders and leveraging a broad spectrum of community assets.

Goodman and colleagues provide a useful definition of community health as “a multi-sector and multi-disciplinary collaborative enterprise that uses public health science, evidence-based strategies, and other approaches to engage and work with communities, in a culturally appropriate manner, to optimize the health and quality of life of all persons who live, work, or are otherwise active in a defined community or communities.” The potential power of community-level health interventions is increasingly recognized. The characteristics of the ecological systems paradigm for community interventions encompass a focus on community capacity and issues identified through community engagement; ecological and systemic perspectives; empowerment of the community; and the permeating role of culture.

Community-engaged health informatics (CEHI) applies information technology and participatory approaches to improve the health of communities. The emerging agenda of CEHI incorporates concepts and methodologies from biomedical informatics, community-based public health approaches, and other fields such as community informatics. Community informatics is the application of information and communication technology to enable and empower community processes. CEHI applies tenets of community informatics in the domain of health. Community-based participatory research (CBPR) is a public health research approach defined as a partnership approach to research that equitably involves community members, organizational representatives, and researchers in all aspects of the research process and in which all partners contribute expertise and share decision making and ownership. Interestingly, CBPR shares many aspects with participatory approaches to information technology design that actively involve end-users in the design process.
Community health interventions can be more effective and sustainable if they build on existing community capacity. CBPR emphasizes community asset mapping. Community-based organizations (CBOs) and service providers are essential assets for building community health interventions. They are important stakeholders in health systems because they provide a wide spectrum of programs and services to members of their community, link with other health and social services to help provide care, and advocate for broader system-level supports. Emerging literature in the area of knowledge translation is also beginning to highlight the potential of CBOs in translating evidence into the community. Many barriers hinder evidence use and evidence-based practices of CBOs. Research has consistently identified that CBOs struggle with: access to evidence; time to process evidence; skills to review, summarize, and synthesize evidence; research terminology; and local applicability and acceptability of evidence. Strategies are needed to address these barriers in order to realize the potential of CBOs as important agents of improving population health.

CEHI takes an ecological systems approach to community health. It extends the notion of Learning Health System to the community-level, and investigates the ecology of community health information in a “cyber-social ecosystem.” The present community intervention seeks to integrate a participatory online environment in the setting of a real geographic community environment. The rationale of the intervention is supported by evidence that online participation and public/civic participation are found to mutually reinforce each other. While many online health communities have broken down geographic barriers by connecting people with similar health interests, it will also be important to build online health communities that have great potential to support health promotion in real geographically defined communities.

The objective of our research was to translate the concept of CEHI into a usable and replicable model informatics platform that will facilitate community-engaged practice and research. The goal of the research is to generate generalizable knowledge and tools that apply to communities outside of Washington Heights/Inwood (WAHI). GHH in WAHI is used as a “laboratory” environment to develop the concept of the CEHI platform. Plans are currently underway to bring CEHI platforms to other communities. This paper describes the methods and results of the GHH CEHI platform design process.

Methods

Setting

The setting of this study, the Washington Heights/Inwood (WAHI) neighborhood, is located in upper Manhattan within New York City (NYC), north of Harlem and directly south and west of the Bronx. It is a densely populated urban area with approximately 280,000 residents. A large proportion of the community residents are Hispanic (71%) and nearly 90% belong to a racial/ethnic minority group. African Americans represent 14% of the population. Most residents are foreign-born, mainly from Latin America, with the vast majority from the Dominican Republic (71%), followed by Ecuador (4%). Less than 50% are proficient in English. The median household income in 2007 was $35,456, and 27% lived below the 200% federal poverty level in 2007. A large percentage (44%) of community residents (persons over the age of 25) did not graduate from high school, and the unemployment rate is over 12%. The most common sources of employment are services and sales industries. Health concerns in the community are significant compared to NYC as a whole. One third (32%) of WAHI residents rate their health as fair or poor, compared to 21% citywide. Residents are less likely to have a regular doctor, more likely to seek care from the emergency department, and more likely to be uninsured. The community rates poorly regarding risk factors for heart disease, with higher rates of high blood pressure, high cholesterol, obesity and diabetes than the overall NYC population, combined with less recreational exercise.

Design Process

Design process is iterative, unique in each case, and may incorporate a variety of practices from different fields. The GHH design process involved a core team at the Department of Biomedical Informatics at Columbia University, including all authors of this paper, and ongoing consultation with community-based organizations and other stakeholders. The idea for GHH originally emerged from lessons learned from another community health portal, GetHealthyHarlem.org, which was previously developed under Dr. Kukafka’s leadership. Whereas GetHealthyHarlem.org was designed primarily for dissemination of local health information to community members, GHH was designed for multiple levels of the community—from community residents to CBOs and other...
community stakeholders—to share health related content and connect with each other. The GHH team sought to
develop a platform that would facilitate community engagement in health practice and research. CBOs with a health-
related mission were recruited as initial primary users. A full range of other stakeholders and related community
sectors may also participate in GHH, including, for example, schools, law enforcement, urban planning, and
religious organizations.

Following is a list of key steps in the CEHI platform design process for GHH. It is important to note that the steps
often deviated from the numeric order shown here, with iterative loops repeating prior steps and with overlapping
steps conducted simultaneously.

1. Preliminary community asset mapping
   The design of GHH is supported by Columbia University’s Irving Institute for Clinical and
   Translational Research, which is the Clinical and Translational Science Award (CTSA) at Columbia
   University. The Community Engagement Core Resource (CECR) of the Irving Institute conducts
   extensive outreach and community asset mapping in WAHI, which is the neighborhood where
   Columbia University Medical Center (CUMC) and the Irving Institute are located. The relationships
   CECR has established with community-based organizations and other stakeholders are the foundation
   for the community-based participatory approach of our design process. CECR is also responsible for
   ongoing site management and promotion, and engagement of organizational users, including
   coordination of the GHH Steering Committee.

2. Logic modeling
   As is common practice in public health program planning25, the team constructed a logic model to
   represent inputs, activities, outputs, and outcomes envisioned for GHH.

3. Guiding principles for CEHI platform
   The team reached consensus on several guiding principles that helped align the work with a common
   understanding of CEHI and architecture of participation.

4. Key informant interviews
   Six semi-structured interviews were conducted with key stakeholders, including community leaders,
   executives of community-based organizations, and leaders of CUMC groups that engage in community-
   based participatory research. The interviews covered a broad range of questions relevant to GHH
   planning, but in this paper we present key themes related to functional needs expressed by the interview
   participants. Several team members engaged in the collaborative qualitative coding process to derive
   these themes.

5. Identification of open-source tools
   One of the guiding principles (see Step 3) was to use open-source tools when possible. The team
   identified suitable tools for the GHH CEHI platform and decided to use Drupal as the primary
   development environment.

6. Exploration of affordances in Drupal
   The team reviewed Drupal documentation, engaged a Drupal developer consultant, and explored design
   features in publicly available health and non-health websites designed using Drupal.

7. Use cases and requirements
   Step 7 occurred simultaneously with Step 6. The team analyzed use cases, partly informed by the key
   informant interviews, and articulated most important requirements for a CEHI platform, given
   affordances available in Drupal.

8. Iterative development process
   Wireframes and prototypes were developed iteratively, working closely with a Drupal expert consultant.

9. Definitions of roles and permissions
   Once the team decided to use Drupal Organic Groups module for the essential participatory
   functionality, a thorough process was undertaken to configure user roles and permissions.

10. Quality testing
    Student interns and other team members conducted a systematic quality assurance process of all features
    of GHH over several months.

11. Soft launch with early adopters
    An initial group of 10 organizations were invited to participate in the soft launch of GHH.
12. Survey of early adopters
During a session that introduces GHH and reviews key functionality, early adopters (n=18) completed a structured survey asking about user needs and reactions to GHH functionality.

13. Plan for full launch
A detailed plan was developed for full community-wide launch of GHH, including several strategies of outreach and marketing.

Results
The mission of the GHH CEHI platform was collectively defined by the GHH team and early adopters as “an online community that engages people in Washington Heights-Inwood to connect, discover, and share resources to get healthy”. Figure 1 shows one part of the GHH logic model, representing the sequence of outcomes leading from use of GHH to intermediate outcomes and then to improved community health as the long-term outcome. A degree of shared understanding about the mission, intermediate outcomes, and long-term outcomes was achieved early on in the design process.

The team had extensive discussions to clarify basic principles to guide the design of a CEHI platform. One of them was to use a CBPR approach and to incorporate community stakeholder input and engagement throughout the process to a maximum extent possible. Another principle was to utilize open-source technologies when possible, given their multiple advantages over proprietary tools, such as customizability, flexibility, interoperability, and support options. An essential principle underlying all functional requirements was to strive for opportunities and strategies to increase active user participation. To that end, the team reviewed dozens of publicly available websites, with a special emphasis on health-themed sites, and listed ideas for functions that facilitate contributions from and engagement by users.

Semi-structured key-informant interviews were used to further elicit input from important stakeholders. The six key informants included community leaders, executives of community-based organizations, and leaders of community-engaged research and service providers from the medical center. Table 1 shows key themes that reflect functional needs the informants expressed for accomplishing their work with the WAHI community. Six themes are listed, with sub-themes under each. There was a high degree of agreement across the different types of key informants. For example, both community-based and medical center-based informants emphasized the first five main themes listed in Table 1. Although medical center stakeholders expressed more needs around research production and use, research related needs were also discussed by community-based participants. The interview data provided the team an understanding of higher-level functional needs among potential users.
Table 1. Qualitative interview coding themes for functional needs among key informants.

<table>
<thead>
<tr>
<th>Main Theme</th>
<th>Sub-Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections with organizations and people</td>
<td>Networking</td>
</tr>
<tr>
<td></td>
<td>Finding collaboration partners</td>
</tr>
<tr>
<td></td>
<td>Knowing who is doing what/working on what issues</td>
</tr>
<tr>
<td></td>
<td>Ongoing conversation and exchange</td>
</tr>
<tr>
<td>Information on community needs</td>
<td>Awareness of problems/issues affecting community</td>
</tr>
<tr>
<td></td>
<td>Access to community-specific data</td>
</tr>
<tr>
<td>Information on community resources and services</td>
<td>Up-to-date, comprehensive, and trusted list for referrals</td>
</tr>
<tr>
<td></td>
<td>Having a place to go to find a current health related resource</td>
</tr>
<tr>
<td>Information on health</td>
<td>Useful health education materials</td>
</tr>
<tr>
<td></td>
<td>Current expert information on health issues</td>
</tr>
<tr>
<td></td>
<td>Desire to share one’s expertise</td>
</tr>
<tr>
<td>Communication with constituents</td>
<td>Gaps in existing communication methods</td>
</tr>
<tr>
<td></td>
<td>Marketing in community</td>
</tr>
<tr>
<td>Research production and use</td>
<td>Recruitment</td>
</tr>
<tr>
<td></td>
<td>Dissemination</td>
</tr>
<tr>
<td></td>
<td>CBPR participation</td>
</tr>
</tbody>
</table>

The next step in the process described in the method section (Step 5) involved identification of suitable open-source technologies. Based on discussions with experts and examination of functionality, Drupal open-source content management system was selected as the primary tool for building the GHH CEHI platform due to its rich functionalities, support for multilingual sites, support for multiple content types, advanced user management that allows for multiple site stakeholders, stability, and scalability. Open source LAMP stack (Linux operating system, Apache HTTP server, MySQL relational database management system, and PHP programming language) was used as software components of the underlying platform. An iterative process (Steps 6-8) was undertaken with a Drupal developer consultant to explore Drupal features, refine use cases and requirements, and design several iterations of wireframes.

In response to the findings from use cases and key-informant interviews, the team selected an essential-set of functions to engender community engagement. Selected functions included a community calendar, a local service directory, posting of multiple types of content (e.g., articles, videos, and links), the ability to comment and rate content, integration of social media for content sharing, use of Google Translate (especially for Spanish translation of content), and the creation of social networking groups. For example, the local service directory functionality relates to the interview theme “Information on community resources and services” (Table 1), and the interview theme of “Information on health” motivated the functionality for posting content. The social network group functionality was deemed an essential design point of GHH. It entailed forming subgroups within the general community based on a localized interests or purposes. Groups could be public or private in nature, with the ability to determine their own membership, host relevant content and provide feedback or communicate with its members. A core role of GHH as a CEHI platform revolved around providing this group functionality to the WAHI community. This functionality meets requirements derived from two particular themes listed in Table 1: “Connections with organizations and people” and “Communication with constituents”.

To enable this function, GHH chose to deploy Drupal 7.1 Organic Groups module. The ability to dynamically form groups is core to the social network group functionality of GHH. Groups within GHH are defined by users and have access to communication forums, email, blogging and notification services, content-sharing services, event calendars and links to social media sites. Ownership and management of the group is kept at the community-level through the pre-defined role of a group owner. Specific group features were defined at both the content creation and the content consumption level. By design, Organic Groups also links to Drupal administrative and reporting services, thus allowing GHH to monitor and provide access and security to groups from an overall site perspective. The full vision of GHH is to support local groups within the WAHI community. These groups must be able to dynamically form, grow, shrink and even disappear according to community preferences. Through Drupal Organic Groups, GHH provides this ability online and fulfills a crucial tenet of community-based participatory research.

Given the required type of participatory architecture of GHH, definition of user roles and permissions also became a complex and important design task for the team. Over several weeks, the team constructed a set of user role and permission settings for the GHH site as a whole (Table 2), and sets of permission settings for public and private groups by type of group member status. The public group settings are shown in Table 3.
Numerous issues were discovered during the quality-testing phase. The user roles and permissions in particular required extensive testing and re-testing to ensure functioning of the exact specifications listed in Tables 2 and 3. Other issues involved appropriate requirements for file sizes and formats of content that users can post. Issues of security, including CAPTCHA verification, also required attention. Overall, our experience demonstrated the value of extensive testing and gradual launch process.

Table 2. Drupal permissions settings for four user roles on GHH.

<table>
<thead>
<tr>
<th>GHH Member Status</th>
<th>Anonymous User</th>
<th>Unvalidated User</th>
<th>Authenticated User</th>
<th>Group Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>A non-registered user who visits GHH.</td>
<td>Has registered for GHH but has yet to authenticate their account by using the link in their email confirmation.</td>
<td>A registered user that has authenticated their account.</td>
<td>Responsible for managing group. Role can be assigned to more than one member.</td>
</tr>
</tbody>
</table>

### Usage Permissions

<table>
<thead>
<tr>
<th>Permission</th>
<th>Non-member</th>
<th>Pending Member</th>
<th>Active Member</th>
<th>Blocked Member</th>
<th>Group Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Cancel Own Account</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Search on Site</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Public Content Across Site</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Media on the Site</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Comments</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Post Comments</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Request Group Membership</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Can Request to Create a Partner Organization or Interest Group</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Post Content</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Comment on Group Content</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Post Under Group Name</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View User Profile</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Contact Users Via Contact Form</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Attach Files to Contact Forms</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View and Use Users Email Address</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Group Members List</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Group Members' Profiles</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Manage Group Members' Status</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 3. Drupal Organic Groups permissions settings by group member status for public GHH groups.

<table>
<thead>
<tr>
<th>Group Member Status (only for registered GHH users)</th>
<th>Non-member</th>
<th>Pending Member</th>
<th>Active Member</th>
<th>Blocked Member</th>
<th>Group Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>User has not requested group membership. Group Manager needs to change status to Active.</td>
<td>Group Manager has approved request for membership by assigning Active status to member.</td>
<td>Group Manager has blocked member from group.</td>
<td>Responsible for managing group. Role can be assigned to more than one member.</td>
<td></td>
</tr>
</tbody>
</table>

### Permission

<table>
<thead>
<tr>
<th>Permission</th>
<th>Non-member</th>
<th>Pending Member</th>
<th>Active Member</th>
<th>Blocked Member</th>
<th>Group Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Request Group Membership</td>
<td>Yes</td>
<td>NA</td>
<td>NA</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>Group Listed on Dashboard</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Group Content</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Headings</td>
</tr>
<tr>
<td>Can Comment on Group Content</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Post Under Group Name</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Edit Group Content Posted by Him/Her-Self</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Edit Group Content Posted by Other Group Members</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Listed on Group Membership List</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Group Members List</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can View Group Members' Profiles</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Contact Individual Group Members</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Access Group Members List-Serve Function</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Manually Add Group Members</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can Manage Group Members' Status</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
To provide a feel for the final design product at this stage, Figure 2 shows a screen-shot with some of the participatory functions. (The full website is accessible at http://www.gethealthyheights.org.) On the top left of Figure 2 is the list of content categories used during the soft launch. This list is currently undergoing revision, based on feedback from early adopters. On the bottom left is community event calendar, which has received extremely positive early user feedback. The right hand side shows the area where users can post different types of content (articles, videos, services, links, and events). We will continue an iterative process of gathering further user feedback and refining the functionality. For example, focus groups are planned to obtain feedback from the community member perspective.

![Figure 2. Screen-shot from GHH, illustrating participatory functionality.](image)

Early adopters (n=18) were asked to participate in a brief survey during GHH orientation sessions. One of the survey questions asked users to indicate how likely they think they are to use specific features of the site. The data are shown in Figure 3. The team is currently using this information to further refine functionality. For example, early adopters indicated an interest in linking GHH with social media with 90% responding that they are very likely or somewhat likely to promote GHH on social media (Twitter, Facebook, etc.). As a result, the team is designing more robust features for social media integration. On the other hand, fewer people indicated likelihood to become regular content contributors or post articles, prompting the GHH team to design a strategy for systematically inviting contributions. During the early use period, we discovered that CBO users preferred to create user names on behalf of their organizations, rather than as individuals. This is an example of users appropriating technologies their own ways, sometimes contrary to the designer’s intentions. We decided to allow organizational user names on GHH.
Figure 3. Self-reported anticipated likelihood of GHH use scenarios among early adopters.

The CEHI platform configurations are presented here as the primary outcome of the research. GHH was launched to an initial set of users from CBOs in April 2015. As of early July 2015, there has been robust use by the CBOs as well as others who have discovered the site. In the first three months, there were 57 registered users, 26 partner organizations, and 5 interest groups on GHH. Table 4 shows further early use statistics of GHH, obtained through Google Analytics. We plan to present updated use data at the AMIA meeting in November 2015, including use patterns of specific functionalities. During the initial months, a steering committee was established as the governing body of GHH. Twelve CBOs are actively participating as part of the steering committee.

Table 4. Early use of GHH.

<table>
<thead>
<tr>
<th></th>
<th>April 2015</th>
<th>May 2015</th>
<th>June 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sessions</td>
<td>777</td>
<td>921</td>
<td>1,198</td>
</tr>
<tr>
<td>Users</td>
<td>473</td>
<td>764</td>
<td>948</td>
</tr>
<tr>
<td>Page Views</td>
<td>3,962</td>
<td>3,209</td>
<td>4,338</td>
</tr>
</tbody>
</table>
Discussion

We have described the methods and results of a design process for the GHH CEHI platform with an architecture of participation. Public health methods, such as logic modeling and community asset mapping, were integrated with information technology design methods, including analysis of functional requirements and iterative development of features to meet user needs. Both qualitative interview data and quantitative survey data were utilized as part of the design process. Throughout the process we show how user needs and requirements are translated into platform configurations and features, resulting in a design product that follows the principles of CEHI and is tailored for the local community. In the GHH CEHI platform, configurations for user roles and permissions became central to achieving the desired participatory functionality with the Drupal Organic Groups module. The general model presented here can be applied as a CEHI intervention in any community but needs to be customized for local needs.

CEHI combines the potential of community-engaged public health interventions with the potential of informatics tools. There is little prior work in this intersection of fields, but an increasing demand for innovative community-level interventions has recently emerged in the context of the Affordable Care Act and healthcare reform. The present study addresses the need for community-level interventions and leverages the power of online tools to facilitate community health in the context of geographically defined high-need communities. Other pioneering community health websites have started emerging in the U.S. and other countries. Examples include websites for Sonoma County, CA (http://www.healthysonoma.org), and London, UK (https://www.myhealth.london.nhs.uk), but GHH is distinguished by its degree of participatory architecture and community stakeholder engagement.

While our aim is to develop a platform that can be adapted for a variety of community settings, one limitation of our work is that the characteristics of the GHH CEHI platform may not be suitable for all communities. For example, it is possible that urban settings with relative density of CBOs and health services may benefit from the functionalities in this type of CEHI platform more than rural communities. On the other hand, rural communities may utilize the CEHI platform in a way that is different, requiring modification to the platform’s functionalities. Generalizability of GHH as a CEHI platform will need to be verified in a variety of communities. Another limitation of our work is that we do not have design, programming, and technology infrastructure resources comparable to commercially supported websites.

Future work includes evaluation of GHH use patterns and the impact of GHH on health-related agency and service networks in the WAHI community. We plan to measure community network connectivity outcomes using system-level network analysis techniques. We are currently collecting baseline survey data on the social network connections among agencies in WAHI. The evaluation plan involves measurement of the network connectivity over time and correlating use of GHH with network connectivity outcomes. In order to demonstrate impact on specific community health outcomes, we plan to identify health conditions and specific projects that utilize the GHH platform. Some of the projects under discussion include focus on obesity, breast cancer, and healthy aging. We also plan to develop informatics approaches to further community asset mapping, with the goal of building a robust and updatable community service directory as part of GHH. GHH is intended to be a CEHI platform that allows further exploration of novel functionalities that promote community engagement and community health. Additional desired functionalities include centralized access to data on WAHI and exploration of opportunities to exchange data among community agencies. We will identify best practices for managing and evolving a CEHI platform of this size and scope. A well-structured development and release methodology will be documented based on the GHH team’s experience. After a number of release cycles, the information will be disseminated to the CEHI community to assist in the development of other CEHI sites.

Conclusion

GHH was developed as a model platform for CEHI. This work begins to expand biomedical informatics into the community-level, which is where many important determinants of human health occur. CEHI approaches, such as GHH, are needed to facilitate engagement of community-based assets and resources to promote community health. A CEHI perspective expands the vision of the Learning Health System beyond medical care settings, to fully include community stakeholders in the health data ecosystem.
References