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The Role of the University Library in Creating Inclusive Healthcare Hackathons: A Case Study with Design Thinking Processes

Bethany S. McGowan
Purdue University, bmcgowa@purdue.edu

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Abstract

Librarians can utilize design thinking practices to develop instructional materials, in the development of new products and services, and in prototyping novel solutions to problems. This paper will explore the role of design thinking in teaching and learning via the use of the Blended Librarians Adapted Addie Model (BLAAM), and will illustrate how well-designed learning approaches can be used to create inclusive learning environments. It will present a case study showcasing how an academic health sciences librarian utilized a design thinking process to create a health data literacy instruction service that encourages diverse participation in healthcare hackathons.

Keywords

Design thinking, hackathons, data literacy, health, diversity

Introduction

This study was conducted at a large, STEM-focused research university in the United States. Librarians at the university hold tenure-track faculty status and frequently collaborate with faculty and instructors in other disciplines across campus and as a result, a range of interdisciplinary and multidisciplinary information literacy, research data management, and data literacy services have been offered for well over a decade. The university's teaching philosophy centers around student-centered learning, an instructional approach that seeks to actively engage students in the learning process. (Maybee, et. al, 2017) Though the university hosts many extracurricular data challenges each year, students from health sciences disciplines are often underrepresented at those events. But, big data in healthcare has become a prominent issue and is being used to identify and manage high-risk and high-cost patients, and used in the development of precision medicine services. (Ellway, et. al., 2014) Health sciences graduates with experience transforming large biomedical datasets into usable information, products, and services have a valuable, in-demand addition to their academic experience. (Schneeweiss, 2014) Additionally, the health sciences disciplines at this university tend to be diverse, particularly in terms of having higher percentages of women and members of minority ethnic groups when compared to other STEM disciplines, offering the opportunity to recruit participants from diverse backgrounds and participants frequently underrepresented in traditional data hackathons. (Decker et. al., 2015)

Can librarians develop extracurricular activities that encourage health sciences students to participate in health data challenges? This paper will seek to answer that question by applying design-thinking processes, specifically the Blended Librarians Adapted Addie Model, to the creation of a new library service that encourages a more inclusive learning environment for health sciences students interested in working with large biomedical datasets.

Healthcare Hackathons as Data Literacy Instruction Opportunities

Hackathons offer a means to gather an interdisciplinary group of participants to solve a specific real-world problem and learn from one another. They encourage participants to utilize design thinking approaches to innovate, require a successful pitch that convinces stakeholders of the usability of a solution, and require participants to quickly respond to feedback and adjust their proposed solutions accordingly. (Silver, et. al., 2016) Though hackathons have roots in the technology industry, they have been embraced by academia and by libraries (Burton, et. al., 2018) as a vehicle for inquiry-based and student-centered learning, and have been used in health-related disciplines as a means to encourage students to be both information seekers and knowledge creators as they find and analyze biomedical data to create an end-product. (Camacho, et. al., 2018; Decker, et. al., 2015; Duhring, 2014; Kienzler & Fontanesi, 2017) To make it easier to describe hackathons to healthcare professionals--healthcare administrators, physicians, nurses, etc.--unfamiliar with the concept but whose buy-in would be needed to support such events, Silver, et. al. define the term *healthcare hackathon* as "a competitive event (live or virtual) that has three specific goals--accelerating the innovation of medical solutions, improving the design in the beginning stages, and supporting educational training for all participants--and aims to accomplish them by focusing on a specific problem (pain point), bringing together in an open innovation format (internal and external resources) an interdisciplinary group of individuals (hackers) that include, but are not limited to, physicians and other healthcare professionals, data scientists, engineers, user interface designers, business professionals, students and other stakeholders who work in teams and follow a process to develop initial prototypes, pitch them to a panel of judges experienced in innovation and quickly alter them according to the feedback (pivoting)." [p.177] (Silver, et. al., 2016).

Participation in healthcare hackathons helps current and future health professionals identify, consider, and develop solutions to challenges associated with how big biomedical data influences patient well-being, and hackathons are particularly useful for better understanding challenges associated with the underuse of uniform data standards and challenges associated with navigating siloed data. (Silver, et. al., 2016; Schneeweiss, 2014) Health professionals who can overcome such challenges to design care responses based on data generated from the healthcare systems in which they work and in which their patient data was originally created, can provide more tailored care, improve their understanding of the effectiveness of treatments, and improve the prediction of health outcomes. (Schneeweiss, 2014) This ability to transform data into actionable knowledge can supplement the information provided by research studies, where patient populations might be different or which might have been conducted in a controlled research environment. (Schneeweiss, 2014) In his exploration of learning from big biomedical data, Professor of Medicine and Epidemiology Sebastian Schneeweiss, suggests that health care professionals should understand how to analyze the data being collected in their local health care systems to inform patient care, using the same hospital information systems that already generate that data. Schneeweiss offers a few considerations to facilitate learning from such health data outputs: 1. Methods should ensure that the patient groups used in comparison groups are similar; 2. Aspects of analyses should be automated without losing validity; 3. Automated analyses should be repeated in cycles synced to data refreshes; 4. Software solutions should be intuitive and require only minimal investment of time and training to set-up

and use; 5. Analysis results should be easily digestible for both busy clinicians and patients. These considerations are useful for Hackathon participants designing software applications and for judges evaluating hackathon participant submissions. Schneeweiss suggests that learning to treat patients with the data that they themselves generate and understanding the aforementioned considerations will lead health professionals to actionable practices that improve patient treatment and outcomes. (Schneeweiss, 2014)

Applying Design Thinking to Promote Inclusion in Hackathons: The BLAAM Model

Criticisms of hackathons include that they promote a culture unwelcoming to women and underrepresented minorities by 1. fostering an overly competitive environment; 2. using a format or following a schedule that potential participants might find unappealing, i.e. staying up for days on end; and 3. lacking in diversity, which leads to feelings of otherness. (Decker, et. al., 2015) The proposed library service seeks to alleviate these issues, using design thinking to guide the creation of inclusive activities that leverage current interest in hackathons and extend that appeal to members of minority communities. To achieve this goal Rune Pettersson's information design principles guided the marketing and promotion efforts, while Steven Bell's design thinking approaches guided the service formation. (Bell & Shank, 2007; Pettersson, 2014; Petterson & Avgerinou, 2016) Service formation and related outcomes are addressed in this paper.

Utilization of design thinking approaches are the basis of Steven Bell's *Academic Librarianship by Design*, in which Bell offers an academic librarian's perspective of design thinking: "we want to optimize the user's satisfaction, and our motive is deeper learning. We too can creatively develop those design elements [performance, quality, durability, appearance, and cost] to benefit our user communities" [p. 43]. Bell suggests that design takes place in three ways within libraries: 1. across products, 2. across environments, and 3. in communication. He introduces a model created specifically for use by librarians to design instructional products and user-centered services, the Blended Librarians Adapted Addie Model (BLAAM). (Bell & Shank, 2007)

BLAAM acknowledges that instructional librarians often lack the time, staff, and money for full-scale design projects, but encourages the use of design thinking processes to develop services. The model is an adaptation of the ADDIE (analyze, design, develop, implement, and evaluate) model, modified for the library instruction environment and consists of five phases: 1. Assess 2. Define Objectives 3. Develop 4. Deliver 5. Measure. A description of each phase is summarized below.

Assess. Understand the needs of the learners by discussing anticipated outcomes and goals with the stakeholder, then assess students via an informal needs assessment. Use the results of the stakeholder interview and needs assessment to develop a problem statement that identifies gaps in service, or highlights needs for instructional tools. (Bell & Shank, 2007)

Define Objectives. Establish objectives that set measures for product or service success. Each project should have 3-4 objectives. Bell recommends the A-B-C-D technique for developing objectives: A. Audience: who is the intended audience? B. Behavior: at the end of the

instruction or service, what behavior changes should the learner have made? C. Condition: what condition do learners need to execute the learned behavior? D. Degree: establish a standard for deciding when the learner has achieved the objective. (Bell & Shank, 2007)

Develop. Produce learning or service materials. Develop a plan for the new service or product, share it with colleagues and stakeholders, and collect their feedback. Edit the plan as needed, then develop the final product. Formal evaluation can be done after the product or service is launched, via a survey of the learners. (Bell & Shank, 2007)

Deliver. Use the instructional tool or service. Instructors should be trained and comfortable with the new product or service. (Bell & Shank, 2007)

Measure. Measure how well the predetermined outcomes and objectives were achieved. This step provides evidence that learning occurred and helps to highlight needed changes or adjustments. (Bell & Shank, 2007)

BLAAM in Action: Designing an Inclusive Hacking Service for Health Sciences Students

With Bell's BLAAM model as a guide, the librarian designed a library service aimed at improving health sciences students' participation in data hacking activities.

Assess

The idea for a new service emerged from an undergraduate, health sciences evidence-based practice course where students explored datasets but where course restraints did not allow for manipulation or combination of datasets. An observation of campus data challenge offerings, extracurricular activities that would allow students to practice data skills, highlighted an emphasis on engineering, technology, and computer science disciplines. The assessment phase focused on better understanding learner needs by discussing anticipated outcomes and goals with stakeholders, including health sciences faculty, instructors, and students. An informal needs assessment via casual conversation and reference interviews with students suggested that health sciences students thought data literacy was important but were not participating in the many data hacking challenges going on in other areas of campus for various reasons, including discomfort in a competitive hacking environment and time restraints. At the end of a librarian-led class discussion on research data management, a group of health sciences students were asked if they had considered participating in a data hacking challenge. These two quotes summarize the group's response:

"I learned Javascript because I think that knowing at least one programming language and knowing how to work with data will become even more important throughout my career, but I don't think my skills are good enough to compete with, for example, someone getting a degree in computer science. That's why I haven't attended any of the hackathon events on campus." -- quote from an undergraduate student majoring in a health sciences discipline.

"I don't know how to code, no programming languages at all, but I think understanding how to manage raw data is important. I would be interested in a class or workshop or special event,

something that would teach me to work with raw data despite my not having programming knowledge". -- quote from an undergraduate student majoring in a health sciences discipline.

Based on the needs assessment, a problem statement was developed:
How can Librarians encourage health sciences student participation in health data hacking challenges?

Define Objectives

Bell's A-B-C-D technique, as previously explained under the 'Define Objectives' phase of the BLAAM model, was used to define service objectives:

1. Audience: The intended audience was undergraduate students in health sciences disciplines. Many of these targeted disciplines--nursing, nutrition, and psychology, and speech, language, & hearing sciences--provided an opportunity to recruit from a diverse pool that included significant numbers of women and members of underrepresented minority groups, audiences often underrepresented in data hacking challenges.
2. Behavior: By the end of the service, learners should be able to locate relevant open-source datasets, clean and organize raw data, combine data from multiple sources and in multiple formats, and use their cleaned and formatted data to build an application using the Javascript programming language.
3. Condition: To execute the learned behavior, learners should be comfortable searching the web for open datasets, finding datasets in library-provided databases, be able to select the appropriate tools to clean and combine data in various formats, and have a beginner's knowledge of the Javascript programming language.
4. Degree: Learners will be assessed by the quality of their project deliverable—a functioning Javascript application prototype using at least one open data source. They will also be assessed by the improvement of their application over the course of the data hacking event (for individual hacks) or by peer evaluation of their contribution to their data hacking team (for team hacks).

Service Objectives:

1. The proposed service aims to motivate health sciences students to participate in health data hacking challenges by providing opportunities complementary to the interests, skills, and experience of students and professionals in health-related professions.
2. Participants will demonstrate an ability to execute data literacy-related competencies, including the management of large biomedical datasets, to create an application, service, or tool.

An healthcare hackathon service was conceptualized, and a sample hackathon challenge was created:

Scenario. Diseases and viruses are common in the U.S. media landscape and public mindset, public awareness, and knowledge tend to be easily affected and directed by news stories. This often shapes a discourse of fear. Imagine you’re hearing the news about the return of a disease or virus (you can choose a specific virus) and you want to figure out the probability of it

spreading to your area. This could be based on geography, proximity to cities, mountains, lakes, plains, traffic connectivity, climate, airports, etc.

Task. Using open data from the CDC and mapping it to environmental and travel conditions, build an application that will make the public more educated about the current state and impact of viruses so they can make better-informed choices as they travel inside the U.S.

Mandatory Requirements.
1. Your application must use the mandatory dataset: Climate Data Online
2. Your application must use at least one more datasets from Data.gov
3. Your application must be written in the JavaScript language
4. Your website must integrate a mashup
5. The code submission must be complemented with a readme file
6. The readme file must have metadata: keywords, a brief description, a unique identifier of the author, a browser within which it was tested (must be Chrome)
7. Your application must use one of the suggested libraries: arbor.js, D3.Js, or sigmajs.

This sample challenge was shared with colleagues for review, including fellow librarians with data science interests, faculty in health sciences disciplines, and faculty with interest in open digital innovation. Their feedback was used to help visualize a challenge model.

Develop

After the needs assessment was conducted and a clear idea of service objectives was defined, the librarian used the BLAMM model to develop a plan for a new health data hacking service. A collaboration was forged between the Libraries and the Research Center for Open Digital Innovation, where a research team had designed and tested a new hacking competition design appropriate for beginner hackers called IronHacks, three-week competitions where each participant worked independently with integrated feedback from technical and user experience experts. (Brunswicker, et. al., 2017) A plan to collaborate to host a healthcare hackathon began with a recruitment strategy that encouraged the participation of novice developers and data scientists by providing pre-hackathon training that would allow all participants to meet the basic level of coding and data science skills needed to actively participate in the hack. This provision of introductory data literacy training to attract novice developers and data scientists combined with a self-paced hacking model that provided iterative feedback formed the heart of the hackathon service's diversity commitment. The service, then, consisted of two integrated parts: 1. pre-hakathon workshops that introduced the data literacy competencies needed to compete in a health data hacking challenge, and 2. hacking events with iterative feedback that allowed participants to practice and execute the data literacy competencies learned in the workshops. Pre-event training opportunities included a Data Hacking Workshop Series that included research data management workshops, an OpenRefine workshop for cleaning and combining datasets, a Gephi workshop for data visualization, and Javascript training. The workshops encouraged participants to research and develop the methods, software, and tools needed to analyze biomedical big data in advance of the hacking challenge. Participants were recruited from a range of backgrounds through campus and community promotional activities--via

campus activity fairs, through student organizations, and via recruitment in entry-level computer science and health sciences courses. To encourage diverse participation, outreach efforts were tailored to organizations like the regional clinical and translational science institute (CTSI) and campus cultural centers, as well as local civic hacking organizations and maker spaces. A budget was created and funding was sought, resulting in the receipt of a National Institutes of Health (NIH) Big Data to Knowledge (BD2K) Hackathon Award, for which the Librarian was the primary investigator.

Deliver

After receiving the NIH BD2K Hackathon Award, the proposed library hacking service was formally titled the Biomedical Big Data Hacking for Civic Health Awareness Project. To better meet the award requirements, the target audience for the hackathons was expanded to include graduate students, faculty, staff, local health professionals, and members of the public. The BD2K Hackathon Award funded two projects--Black Ironhack in Fall 2016 and the Libraries Health Data Hackathon in Spring 2017. Black Ironhack was co-hosted by the Libraries and the Research Center for Open Digital Innovation and utilized a pre-existing hackathon structure. The IronHacks model is a 21-day, 4-stage self-directed hacking initiative that allows hackers the time and flexibility to create well-developed applications. At the end of each stage, participants receive feedback from experts and future app users. Black Ironhack asked participants to use open health and travel data to address health challenges, specifically to create a tracker for travelers interested in evaluating their risk of virus exposure. Participants were required to create a web application and mashup (or combine) at least two open datasets.

Guidelines for the IronHacks are:
1. Submit at least one application at each of the 4 hacking phases
2. Discuss general questions on the IronHack forum only. Do not communicate solutions with competitors or others.
3. Do not work in teams. IronHack is an individual competition.
4. The code you submit in the first phase does not have to be a fully working application, it can be a non-interactive prototype (even an image).
5. You must be the originator of the code. Be ethical!

The event timeline was as follows:
August-September 2016: Data Hacking Workshop Series
September 14, 2016: IronHack Training Session
September 21-23, 2016: Self-Directed Hacking Phase
September 24-26, 2016: Expert Evaluation Phase 1
September 27-29, 2016: Self-Directed Hacking Phase 2
September 30-October 2, 2016: Evaluation Phase 2
October 3-5, 2016: Self-Directed Hacking Phase 3
October 6-8, 2016: Evaluation Phase 3
October 9-11, 2016: Self-Directed Hacking Phase 4
October 12-18, 2016: Evaluation Phase 4
October 19, 2016: Awards Ceremony and Announcement of Final Winners

89 participants registered for the Hackathon and 43 participants attended at least one of the pre-hackathon training sessions. 36 projects were submitted in the first phase, 13 submitted in the second phases, 9 submitted in the third phase, and 6 projects were submitted for final review at the end of the 21-day hackathon. Expert evaluations and feedback were based on usability, technological performance, and user experience.

The Purdue University Libraries Health Data Hackathon was a 2-day hackathon hosted by Purdue University Libraries in Spring 2017. Participants were asked to use open-source data to identify health trends and opportunities, then work as a team to design an app to track behavior and enhance communication between consumers and health information sources. Each team was assigned an early-career healthcare professional to advise on current challenges related to working with biomedical data. 25 participants registered and 7 participants submitted final projects, with the winning team including a nurse who blended clinical experience, patient communication knowledge, and computing expertise to develop a pharmaceutical drug distribution app. The winning project codes and presentations are available on Github: https://github.com/anajaved/Heath-Data-Hackathon https://github.com/will1397/Health-Data/tree/master/HealthDataApp/app/src/main

Measure

In his discussion on learning from big health care data, Schneeweiss identified navigating siloed data and consistent lack of use of uniform data standards as two major obstacles for health professional's utilization of big health data. (Schneeweiss, 2014) These are both issues in which librarian expertise and instruction can be instrumental. Though Schneeweiss focused specifically on data from electronic health records, these issues are also reflected in open datasets from government agencies and private organizations, propriertary data in subscription databases, and NGO datasets. Though the study findings for this service represent a single site case study and are limited as such, both issues identified by Schneeweiss emerged as the most popularly reported challenge for hackathon participants. Qualitative feedback from post-event interviews with participants who submitted final projects revealed the desire for further training in data management, particularly data organization, data collection, and data analysis. For example, one winning participant expresses such concerns during his post-event interview, recorded at the Black IronHack awards ceremony: https://vimeo.com/188211462. Participants also reported wanting to improve the efficiency of their data collection and data analysis practices with either pre-hackathon training or a guided data management component during the first day of hacking.

Participants noted a few logistical concerns. Downloading multiple large datasets caused the wi-fi to be slower than expected during the first day of the Libraries Health Data Hackathon, which was especially problematic and frustrating for hackers working with a short timeline. And, a sponsor provided snacks for the Libraries Health Data Hackathon, but participants reported that lunch, even just pizza or sandwiches, would have been more useful as they would not have needed to break for lunch.

Next Steps

Instructors interested in communicating with, and teaching for a diverse audience will discover that applying a design thinking approach to the creation of instructional services is valuable for guiding their development and for prototyping novel solutions to problems. Launching services without a clear context can disable the learning cycle, but instructors able to present clear outcomes and objectives in relatable culturally-sensitive and audience-specific ways, have a greater capacity to launch sustainable services. For this project, the goal was to create a service that encouraged diverse participation in healthcare hackathons by offering extracurricular data hacking challenges that health sciences students would participate in. That goal was met with over a quarter of total participants, 28%, being from a health sciences discipline. Considering registrants for both hacks, 38% were women and 46% were members of a racial minority group. There was, however, a high rate of attrition between the number of registrants and the number of participants submitting final projects. This was true for both hacks--Black IronHack began with 89 participants registered and concluded with only 6 final projects submitted, and the Health Data Hackathon was capped at 25 registrants, with only 7 participants actually attending. However, all attendees who participated on the first day of the hackathon felt invested enough to return for the second day. To improve retention rates, future action will include research to better understand causes for failure and rates of attrition in hackathons and similar data challenges.

Both hackathons were extracurricular activities and participant motivation was likely incentivized by the prestige of participating in an NIH-sponsored hackathon event and by the offering of monetary awards for winners, however, funding for the Biomedical Big Data Hacking for Civic Health Awareness Project was limited. To sustain this Libraries hackathon service, present and future action will include continued collaboration with the Research Center for Open Digital Innovation, collaboration with the Health and Human Sciences Office for Diversity and Inclusion, and the continued pursuance of grant and award funding. Since launching these hackathons, the librarian has helped to launch a multidisciplinary undergraduate learning community focused on critical data studies, addressing the ethical and social aspects of big data. This living and learning community offers a readily-accessible pool of potential participants for health data hacking challenges. The hackathon service will continue although its name will likely change.

Relatedly, healthcare hackathons introduce the opportunity to explore issues related to critical data studies. Specifically addressing questions regarding who collects biomedical data; where does biomedical data come from; what challenges are associated with combining, formatting, storing and analyzing big biomedical data from different systems; and who controls and owns biomedical data. Also, what privacy concerns need to be addressed by health professionals using data from patient health records and hospital information systems?

Conclusion

This study revealed that health sciences students are interested in working with big data, but do not always have the coding expertise to compete in hackathon competitions. Results from the initial needs assessment at the beginning of the service design project suggest that there are students interested in learning to manage data, but not particularly interested in learning a

programming language. Future action might include expanding services to include data-related challenges that do not require coding, such as datathons, humanitarian mapping events, ideation challenges, case competitions, and policy challenge competitions.

To improve attrition rates, future action might include either integrating a hackathon model, like IronHacks or a similar approach, into existing health sciences courses or creating a hackathon-based course for upper-level health sciences undergraduates to provide health sciences students with experience wrangling big data and with a tangible deliverable they can share with potential employers.

When asked in post-event conversations, participants consistently reported either finding or formatting data as the most difficult challenge. Addressing this issue ahead of or during hackathons might provide an additional means to reduce attrition rates. This also provides librarians, even those uninterested in hosting hackathons, the opportunity to offer data management training in various forms. These might include hosting a data management workshop series prior to hackathons, hosting pre-hackathon training that focuses on data management practices, and librarian involvement in data-centric health sciences courses or labs as data management experts.

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