Development of an evidence-based medicine mobile application for the use in medical education

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Thesis

DEVELOPMENT OF AN EVIDENCE-BASED MEDICINE MOBILE APPLICATION FOR THE USE IN MEDICAL EDUCATION

by

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DEDICATION

To Peter Kiley, my best friend and lifeline.
ACKNOWLEDGMENTS

“So reach into your pocket right now. More likely than not, your hand will curl around your smartphone. Right there is your invitation to make queries regarding patient care, engage in lifelong learning, contribute your expertise, and join the conversation within the global medical community.”

- Dr. Michelle Lin, Deputy Editor for Dynamed

I would like to acknowledge the following people, for without them I would not have been able to be part of such a unique and exciting research opportunity: Dr. Theresa Davies for your incredible guidance, Mr. Dave Flynn for keeping me sane while laughing, Dr. Miriam Hoffman, Dr. John Wichita, and Dr. Molly Cohen-Osher for their creativity and wealth of knowledge in EBM, and the entire EBM-VIG committee. Most importantly, to the members of the Global App Initiative that have taught me so much about coding, and allowed me a glimpse into the world of engineering: Raymond Li, Aihoa Le, Lisa Nguyen, Calvin Chin, Omar Janoudi, Marika Lee and Habib Khan.
DEVELOPMENT OF AN EVIDENCE-BASED MEDICINE MOBILE APPLICATION FOR THE USE IN MEDICAL EDUCATION

ANNIE LIU

ABSTRACT

Background: Evidence-based medicine (EBM) is a methodology that is being incorporated into more medical school curricula. Boston University School of Medicine was one of early adopters of Evidence Based Medicine in the United States. A growing concern in the medical community was that the complexities of applying EBM might be lost when students enter into their clinical rotations, thus there is a need for development of a tool to help reinforce the EBM principles.

Methods: The research team in collaboration with the designers of the Finding Information Framework, a custom-made EBM finding information tool, worked to develop a mobile application to help reinforce the framework for medical students. The app was designed with both Apple and PC operating systems in mind. Key features that were identified from current literature to provide the most user-friendly mobile application. Thus, the research team specifically utilized iOS and Android platforms as both platforms have a centralized app store, possess the highest volume of medical apps available, and are most widely used in the United States by medical students.

Results: The Finding Information Framework was a custom-made tool developed to guide new users of EBM, and help them to apply the principles in practice. The mobile application served an added convenience by allowing easy access and fast utilization of
the EBM tools. The app was designed on an Android platform first due to its open-source OS and ease in app development to new programmers. Initially, the user-friendly web-based tool, App Inventor (AI), powered by Massachusetts Institute of Technology was evaluated to program the pilot Android app. Using both the AI Component Designer and the Block Editor, several problems were encountered in AI, such as the simplicity of the program and the lack of freedom in design. This moved the project to create the app natively and with a collaborative effort with the BU’s Global App Initiative club.

Initially, a wireframe was built using Balsamiq. Subsequently, the Android app was built using Android SDK and the iOS app was built in XCode with Objective C; both platforms had design sections prepared in Sketch, Adobe Photoshop and Illustrator. The last and final step was to obtain Boston University branding privileges for the app.

**Conclusion:** The research team identified necessary features based on research to build a user-friendly, professional mobile application of an information mastery framework that can be used off-line. The app is called FIF as it is the title of the information mastery tool designed by BUSM EBM-VIG. With a clear mobile interface, it will be beneficial to the learning and training of medical students in EBM.
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LIST OF ABBREVIATIONS

AAMC……………………………………………………..Association of American Medical Colleges
App……………………………………………………………….(Mobile) Application
AI…………………………………………………………………..App Inventor
AVD……………………………………………………………….Android Virtual Device
BU……………………………………………………………………..Boston University
BUSM………………………………………………….Boston University School of Medicine
EBM……………………………………………………………Evidence Based Medicine
FIF………………………………………………………………..Finding Information Framework
GAI…………………………………………………………………..Global App Initiative
IS&T……………………………………………………………..Information Services and Technology
OS………………………………………………………………….Operating System
SDK……………………………………………………………….Software Development Kit
VIG…………………………………………………………….Vertical Integration Group
INTRODUCTION

I. BACKGROUND

Medicine is constantly growing and changing due to new developments from research and advancements in technology. Yet the practice of medicine has not caught up with these advancements. In modern day medicine, a physician needs to have both clinical expertise and the best available clinical evidence. Without clinical expertise, the treatment provided may not be the best for a patient, and without clinical evidence the practice may be outdated and potentially dangerous to the patient.

Therefore, the practice of evidence-based medicine (EBM) is a solution that addresses the changes in medicine. It is a systematic approach in clinical decision-making, which incorporates the best and latest clinical evidence from research in conjunction with the patient’s values in deciding the course of treatment (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Over the years, an increase in media exposure and improved patient education on medicine has made patients take on more of an active role in their medical decisions. Therefore, it is important that physicians are kept abreast to the changes and innovations in medicine to be able to address patient needs. EBM is becoming increasingly popular as more medical training institutions recognize the importance of this approach in medicine, as it allows physicians to efficiently and effectively deliver the most current therapeutic approaches to care for their patients (Sackett et al., 1996).
II. HISTORY OF EVIDENCE BASED MEDICINE

The concept of EBM has been around for centuries. The use of anecdotal accounts taught during apprenticeships, documentation in personal journals in the seventeenth century, and the sharing of information through textbooks and peer-reviewed journals in the twentieth century are all examples of the practice of EBM in history (Claridge & Fabian, 2005).

However, what is understood as modern-day practices of EBM was first founded by many influential leaders in the late 1960s, including Suzanne and Robert Fletcher, Alvan Feinstein, and Dr. David Sackett. These leaders all shared a common goal, to introduce clinical epidemiology into the practice of medicine (Sur & Dahm, 2011). Sackett along with his colleagues at McMaster University published several journals for the medical community, which introduced a technique called “critical appraisal.” They believed that it was important to teach methods to understand the literature published, but also to apply the information in practice (Sur & Dahm, 2011).

In 1990, Dr. Gordon Guyatt of McMaster University introduced the term Evidence Based Medicine, which was built from the foundation of his mentor, Sackett. The response from the medical community was unwelcoming because it questioned the traditional practices of medicine, and made implications that the clinical decisions were not as scientific. Fortunately, there were several who believed in this methodology and collaborated to form an international EBM Working Group (Sur & Dahm, 2011). Guyatt and his colleagues continued to publish journals to assist physicians in understanding and applying the research to each patient, which later evolved to include taking patient values.
into consideration. These journals became known as the *User’s Guide to the Medical Literature* (Sur & Dahm, 2011).

The advancements in informatics technology greatly advanced the practice of EBM by increasing the accessibility to journals and thus increasing the sharing of medical research. Three pioneers helped to further the sharing of information through the Cochrane Collaboration, Ian and Tom Chalmers, and Murray Enkin (Sur & Dahm, 2011). The Cochrane Collaboration allowed the sharing of peer-reviewed journals that focused on several key principles, such as avoiding duplication, keeping up-to-date, continuity, and worldwide participation.

### III. MEDICAL EDUCATION

Medical education, in the past centered around often-outdated textbooks and relied on users to actively seek out information from an assortment of sources (Joshi & Lin, 2013). The Accreditation Council for Graduate Medical Education and the Association of American Medical Colleges (AAMC) have recognized deficiencies in medical education based on responses from physicians of unmet skills encountered in practice. These skills included, information retrieval skills, management of updated knowledge after training, and to effectively practice various interventions (Green, 2000). Therefore, several courses, such as clinical epidemiology, critical appraisal, and medical informatics have been introduced to medical school and graduate medical curricula (Green, 2000).
EBM still ranks superior since it incorporates and recognizes an important aspect in health care, the values of the individual patient. In a survey conducted of all the residency programs in the U.S. and 12 Canadian programs, only 99 programs reported a freestanding EBM curriculum (Green, 2000). The survey further revealed that although more programs were adopting an EBM curriculum, there was still a discrepancy in the training of EBM, as it does not address how best to apply EBM effectively at a busy practice (Green, 2000). Moreover, only 5% of the programs surveyed evaluated the actual practice of EBM in a clinical setting after their EBM training. Additionally, one of the biggest criticisms that EBM faces is that it relies on a systematic research to find the best available clinical evidence, yet it does not provide what constitutes the best evidence.

As EBM is taught in more medical schools, a potential problem that has not been addressed is the need to reinforce the tools acquired during their didactic years in order for students to be prepared when they enter into a clinical setting (Sastre, Denny, McCoy, McCoy, & Spickard, 2011). Research has shown that when there is variability in a process, the difficulty in delivering quality care will increase if it occurs in a stressful environment (Flannigan & McAloon, 2011). As medicine is inherently stressful and often occurs in high pressure, fast-paced settings, it is important to reduce the stress and variability in order to provide quality and effective care.

At BUSM, a series of Vertical Integration Groups (VIGs) were created to assess and explore the roles of various concepts in the BUSM’s curriculum. Of the VIGs created, the EBM-VIG was established in October of 2010 and it consisted of a diverse
group of Faculty and Deans from across BUSM. In 2012, the EBM-VIG evolved to a more clinical focus, which included methods to add EBM to the clinical curriculum. Of the methods discussed, the EBM-VIG designed an effective tool to better assist a medical student in learning the principles of EBM and its application.

This tool has now become known as the Finding Information Framework (Figure 1). It was designed to help medical students structure and categorize their clinical questions in order to find the necessary resources, and therefore information to obtain their answers. Specifically, the Finding Information Framework (FIF) is a flowchart, which begins at the top when the student is required to formulate a question regarding medicine. The tool takes the student through a series of steps in order to categorize the question (i.e. background or foreground, basic science or clinical). The type of question is then linked to a final category by the student, and then the student is directed to the appropriate web-based resources. At BUSM, the medical students will study EBM throughout their four years of medical school, and use the tool as a framework to help prepare them in a clinical setting.
Figure 1: Schematic of the web-version of Finding Information Framework. The flowchart demonstrates the flow of information to be utilized, re-enforcing EBM during clinical diagnosis. Figure taken from Vertical integration Group, BUSM.
Throughout history, technology has been influential in how physicians practice. In the early 21st century, physicians were introduced to Personal Digital Assistants (PDA), which allowed them to access wireless data on a handheld device (Amin, 2011). PDAs paved the way toward the invention of smartphones, as they were a hybrid of mobile phones and PDAs. The most successful examples were Apple iPhone and Google Android smartphone (Amin, 2011). Therefore, the current study was initiated in order to develop a mobile app to assist in the learning and application of the EBM skills in a fast-paced clinical setting.

There was a considerable amount of literature indicating the importance of technology in the training process of medical students. A study was conducted in 2012 that measured the number of medical students in the United Kingdom who owned a smartphone and how many of those students utilized medical apps in their day-to-day routine. The study concluded that a large majority of the medical students owned smartphones and the number of smartphone owners would continually increase. Additionally, medical students are very responsive to medical apps that increase their learning and work efficiency (Payne, Wharrad, & Watts, 2012).

Furthermore, a survey in the United States found that 72% of physicians own a smartphone and 95% have downloaded medical apps for use on their smartphone (Draper, 2013). Additionally, not only clinically applicable but the adoption of smartphones through non-medical purposes has made the app platform an excellent and easy vehicle to launch the educational tool, FIF. There were added benefits to focusing our solution around a smartphone, such as the ease and speed in accessing clinical
information, no dependence on network service if the application is downloaded onto the smartphone, and little training needed due to already widespread uses of smartphones and mobile apps (Flannigan & McAloon, 2011).

In the literature review, there were numerous articles indicating the importance of educating medical students on the EBM process, and evidence demonstrating that effective training of medical students on the EBM process yielded sustainable results (Dorsch, Aiyer, & Meyer, 2004). In 2011, a study was conducted at the Vanderbilt University Medical Center on third year medical students. The students underwent workshops to demonstrate how to utilize EBM resources. Afterwards, the medical students indicated that the hands-on workshop allowed them to be more comfortable with the resources and utilize and integrate the EBM process into their clinical routine (Sastre, Denny, McCoy, McCoy, & Spickard, 2011).

The research team was not aware of any literature published on the use of a smartphone app by medical students that could assist and reinforce the EBM processes through a custom-made framework. The closest to a technology-assisted tool in EBM was from a study conducted in 2008, which involved two universities collaborating to develop an EBM search program to aid students. The EBM Search tool could be accessed from a desktop and the responses from a sample of 99 medical students were shown on Table 1. The overall response was positive and the majority of the students utilized the search tool and found it helpful (Mark Keim, Howse, Bracke, & Mendoza, 2008).
Table 1 – Survey of First Year Medical Students Experiences Using A Customized EBM Search Tool. More than half of the first year medical students surveyed (N = 99) at University of Arizona and Purdue University almost always or always used the EBM search tool and a large percentage (73.8 %) stated the usefulness of the tool. (Adapted from Mark Keim, Howse, Bracke, & Mendoza, 2008)

<table>
<thead>
<tr>
<th>Survey items</th>
<th>Always (%)</th>
<th>Almost always (%)</th>
<th>Half of the time (%)</th>
<th>Almost never (%)</th>
<th>Never (%)</th>
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<tr>
<td>I use the <em>EBM Search</em> Tool.</td>
<td>14.5</td>
<td>39.1</td>
<td>34.8</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>The <em>EBM Search</em> tool is easy to navigate.</td>
<td>25.4</td>
<td>50.7</td>
<td>14.9</td>
<td>9</td>
<td>0</td>
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<tr>
<td>The <em>EBM Search</em> tool has been helpful when preparing for case-based learning.</td>
<td>22.4</td>
<td>37.3</td>
<td>26.9</td>
<td>10.4</td>
<td>3</td>
</tr>
<tr>
<td>The evidence ranking system for the search results is helpful.</td>
<td>33.8</td>
<td>40</td>
<td>21.5</td>
<td>3.1</td>
<td>1.5</td>
</tr>
<tr>
<td>I experience technical difficulties when using the <em>EBM Search</em> Tool.</td>
<td>0</td>
<td>7.5</td>
<td>6</td>
<td>56.7</td>
<td>29.9</td>
</tr>
<tr>
<td>When researching my learning issues, the info provided is exactly what I need.</td>
<td>3</td>
<td>35.8</td>
<td>46.3</td>
<td>13.4</td>
<td>1.5</td>
</tr>
<tr>
<td>I feel frustrated when using the <em>EBM Search</em> Tool.</td>
<td>0</td>
<td>10.4</td>
<td>29.9</td>
<td>44.8</td>
<td>14.9</td>
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Additionally, a study in 2009 compared the use of EBM resources that could be accessed through a mobile device to EBM resources that could be accessed through a
web page from a desktop in a clinical setting by nursing students. The students preferred the desktop to the mobile device because they found accessing the Internet from their mobile device too difficult due to poor network connection, and the small display hindered effective utilization (Morris & Maynard, 2010).

IV. OBJECTIVES

The research aimed to identify studies that have been conducted in the past to identify the strengths and weaknesses of mobile apps. Through the research, the best method to deliver the framework will be identified and assist in the development of future medical apps. The objectives were to make recommendations of features that yielded high user satisfaction and were necessary to include in a mobile app. Some of these features were incorporated in the mobile app created, called FIF by the research team and volunteer group. FIF was created on both iOS and Android platforms. The app is called FIF as it is the title of the information mastery tool, Finding Information Framework, designed by BUSM’s EBM-VIG. With a clear mobile interface, it will be beneficial to the learning and training of medical students in EBM.
METHODS

I. APPLICATION RESEARCH

In order to capture a baseline of how BU medical students learn and apply EBM in BUSM’s curriculum, the author attended an information mastery presentation and observed a three-week Family Medicine rotation for third year clerkship students. During the information mastery presentation, Dr. Miriam Hoffman, director of BUSM’s Family Medicine Clerkship, introduced FIF to third year medical students prior to their rotation, and discussed EBM and the value of its application in modern-day medicine. The rotation consisted of three small groups of five medical students, who would practice utilizing point of care resources through hypothetical cases. The students were guided through the many web-based resources available by the Family Medicine professors, including Dr. Molly Cohen-Osher.

Additionally, the research team attended VIG meetings regarding the FIF at BUSM Family Clerkship office. The team met and observed the makers of the framework in order to better understand the rationale behind the various segments of the FIF. Through these meetings, the research team heard actions that were taking place to integrate FIF into the curriculum sooner, and methods to improve student understanding of EBM. At the time, students received formal discussions regarding EBM during their third year of medical school in the Family Medicine rotation. The steps that were recommended and taking place included introduction to FIF during BUSM’s orientation to first year medical students, and tailoring FIF to specific courses so that the framework
could be better integrated into the curriculum and there would be more buy-in from medical faculty. The VIG introduced the FIF website available through the BUSM Alumni library webpage, www.medlib.bu.edu/fif to the research team. The web-based framework was the starting point for the smartphone design.

The research team then conducted studies to determine the best practice on mobile app design. This was conducted through various technology and science journals through BU library’s database. The search was limited to “mobile app designs” and “best practice” or “user friendly” in the past five years with full text availability through the database. The literature search was focused on the past five years as technology is constantly growing and changing, and the research team did not want to review older articles in case features noted were obsolete.

II. APPLICATION ENGINEERING

The app was narrowed to Android and iOS platforms exclusively for several reasons. Both Google and Apple were the only two companies with a centralized app store, which allowed ease for users to search for apps and therefore generated the highest user traffic for apps (Liu, Zhu, Holroyd, & Seng, 2011). Additionally, Google and Apple possess the highest volumes of medical apps available and are known as the leaders in the app market (Liu et al., 2011). Lastly, these two platforms were the most widely used in the United States, and have been surveyed to be the most widely used by medical students (Payne et al., 2012).
An Android platform was initially designed due to its open-source OS and ease in app development to new programmers. The research team used App Inventor (AI) to program the Android app. AI is a web-based tool powered by Massachusetts Institute of Technology that allows users with little programming experience to develop mobile apps. There are two components to AI, the Component Designer and the Block Editor (Hsu, Rice, & Dawley, 2012). The Component Designer functions to allow the programmer to design the app’s interface; i.e. how the user sees the app. The Block Editor functions to show how the user interacts with the app; i.e. the user interface.

The App Inventor had several strengths from a programmer’s perspective. It was easy to use and allowed the novelty of visual programming (Hsu et al., 2012). Therefore, the programmer simply had to drag and drop various features into the platform, and the programmer could easily see the app’s interface. Typically, if the app was built natively, this feature would not be available. A programmer would need to code the app in one program and then run the code through another in order to see the basic skeleton of the app. There were, however, several problems encountered in AI, such as the simplicity of the program and the lack of freedom in design. Although AI was simple to use, the design features that a programmer could drag and drop were very limited, which hindered the creativity and type of mobile application that could be developed. Therefore, the research team sought guidance from the School of Engineering at BU to create an app natively.

Given that there were limitations with the engineering capabilities of the research team, Dr. Ari Trachtenberg from BU’s School of Electrical and Computer Engineering
was contacted. Dr. Trachtenberg was identified through an article published through BU’s newsletter regarding his final class project in Introduction to Software Engineering. The students were asked to design a novel Android app for a field of their choosing. The research team believed that Dr. Trachtenberg would offer valuable advice and could recommend a student to work with the team. Upon meeting with Dr. Trachtenberg, he said that the task of designing an app would be very difficult given the research team’s limited knowledge of app programming. He recommended the app be built as an HTML5, which would be a cached webpage that could still be used on a mobile device.

There are multiple benefits to an HTML5 platform, such as it is simple to build, the functionality is built into the platform, available for offline browsing, and useable for most mobile devices. The weaknesses, however, were a significant decrease in user interaction, browser dependence, and lack of error detection and performance tools. The decrease in user interaction was the most important weakness, which is why the decision was made to build natively.

Instead, with Dr. Trachtenberg’s help, the research team reached out to all of BU’s Electrical and Computer Engineering community. Several engineering students, who were interested in building a medical app, but had little to no experience in app programming contacted the research team. The team was also contacted by the president of Global App Initiative (GAI), a club formed in 2012, who asked the team to pitch the app concept at a club meeting.

GAI is an undergraduate club, which teaches and helps students from a wide range of engineering capabilities to design apps for nonprofit organizations. The members of
GAI must choose a nonprofit organization to work with, and collaborate as a team to develop an app that fits the goals of the client. The members of the club were given the freedom to design an app, with the understanding that the app would accomplish the task that the client requested.

After several weeks of other app presentations, the research team was contacted with a list of GAI group members, who volunteered to help create FIF as their mobile app project. Given the unique circumstances that the research would also be a thesis for one of the members of the research group, GAI granted the author access to observe the development process of the app. Thus, the GAI group along with the author met every week and attended app workshops every Saturday morning to learn the necessary programming skills. These meetings served an added purpose by providing a forum to develop ideas and collect feedback from the GAI members about the app design. Additionally, the workshops helped to set a foundation to code for both Android and iOS platforms.

Initially, a wireframe was built using Balsamiq. A wireframe is an electronic layout of what each screen looks like when a user navigates through the app. The wireframe set the groundwork and was based on the research done by the research team regarding the best practice of app designs. After the completion of the wireframe, it allowed both the research team and GAI members to be in agreement on the functionality of the app.

The Android app was built first using Android SDK, as the program was familiar with some of the engineering students in GAI. Afterwards, the iOS app was built in
XCode using Objective C. The majority of the members of GAI were freshman with little coding experience, and it was a more difficult task to build in XCode since none of the members had experience with the program.

At the start of GAI, the members and the author studied Java with Android SDK, which enabled the development of mobile applications for Android devices. The app was viewed through Android AVD, which is an emulator that allows the builder to view the app as a user on a mobile device. The weekly workshops and drop-in sessions taught the club members how to use Android SDK, and helped to address any concerns that were encountered while building the app.

In the latter half of the research, the program skeleton of the Android app had been completed. Subsequently, GAI was divided into three teams: Android, iOS and design. The tasks for each were specific in that the Android group needed to finalize the program skeleton and served an added purpose in helping new engineers navigate through an almost completed program. The iOS team was tasked with the responsibility of understanding Objective C, in order to build in XCode, and use the Android app as a model so that the features were consistent. Lastly, the design team was responsible in designing the app’s interface so that it was user-friendly and professional. The design team used multiple programs including Sketch, Adobe Photoshop and Illustrator. The author continued to work with each team individually and maintained a constant stream of communication.

GAI, as discussed previously, is an undergraduate, student-run club led mostly by engineering students from Boston University. GAI’s goal is to help students learn how to
build mobile apps, and also develop professional skills. The organizations that GAI helps to build mobile apps typically have a connection to the BU community. In order to help GAI members develop their professional skills, the organizations were referred to by GAI members as the client, and the members needed to meet the client’s deadlines.

Having the author attend the club meetings and workshops as a GAI member, gave the research team an inside-look into the programming and designing of the app. A potential problem of having an undergraduate club volunteer to program an app was the concern in continuously motivating the group in order to meet the deliverables.

Therefore, as a member, the author answered questions that the club had with the applications of FIF, provided input on how the app should look, and most importantly encouraged the club and delegated leadership. Although, GAI assigns a team leader to the group, there was still a disconnect in how the team leader communicated to his group. The team leader was also an undergraduate student with difficulty keeping the group motivated, especially as attendance started to decrease. Therefore, the author worked closely with the team leader to enhance his leadership skills and assisted in motivating the group. The author sent emails to highlight key point of the meetings, and provided positive feedback to club members for their significant contributions. The author also became an asset to the group members as she could serve as a reference for the GAI members, as they search for internships and applied for jobs.

Throughout the development phase, there were continuous meetings with the research team and EBM-VIG to update each of the groups on the process, and to maintain open lines of communication and ample opportunity for feedback between groups.
III. APP PUBLISHING

The last and final step was to obtain branding privileges for the app and obtain information in order to publish the app through the Apple iTunes App store and Google Play. The research team received authorization through the BU branding office to access the BUSM logo. The author met with Trevor MacDowell, a program manager from BU Information Services and Technology (IS&T), who explained the necessary steps in order for BU to publish the app through the iTunes App store.

Apple requires all apps to be approved by Apple in order for an app to be published through their App store. The approval process takes approximately two weeks, and a $99 fee is charged in order to open a developer’s account. There were three methods to publish an app through Apple. The most common was through the iTunes App store, which required a developer account that BU already had established. The other methods included an enterprise and educational distribution. An enterprise distribution is for a specific population that can be granted access to the app within an organization without having to purchase from the App store. The Enterprise Program can be purchased from the App store to serve as a platform to distribute the app in-house for $299 per year. An educational distribution is when Apple grants a developer account to a faculty member, who will teach in a classroom and can only be distributed to a limited number of computers.

Upon given these options, the research team opted to publish with BU through the App store. BU IS&T discussed that in order for app to be published by BU there were also requirements. The organization needed to be affiliated with BU, the BU brand must
be located on the initial page of the app, a project request must be completed, and a designated support system must be in place before an app is published. The app can be supported by a third party and does not necessarily need to be supported by the original programmers of the app, as in the case of BU’s Bike Safety app. MacDowell offered the services of IS&T to help support the app over time since he was aware of GAI, and that the students would graduate and be unable to support the app past this year. IS&T charges $65 per hour, but MacDowell said he was unsure as to what the app presently looked like in order to determine if the app needed further work aside from maintenance.

Google Play does not have strict requirements on app publications. It can be published through Google’s Enterprise distribution where the app is posted in Google Play and downloaded and installed by the user onto an Android device.

Furthermore, MacDowell added that he had experience with GAI, and explained that the club has not published an app since its inception two years ago. He said many prototypes have gone through his department and they have been good prototypes, but the apps were simple and unable to be published because it did not satisfy the necessary requirements listed previously before it could be published.

With the limited resources available to the research team and time invested already in GAI, the research team decided to move forward with GAI and develop an app. MacDowell’s recommendations may be explored more in the future.
RESULTS

I. APPLICATION PREWORK

During the information mastery presentation and family clerkship rotation, EBM-VIG received a widespread positive response from the medical students regarding a mobile app version of FIF. The author observed that during rotations, although most students had their laptops, they relied heavily on smaller devices, such as iPads and their smartphones. The author observed that the overwhelming majority of students owned either an iPhone or an Android phone, which was also what previously published literature had shown. There were also multiple medical apps that students were familiar with and reported using frequently, such as Epocrates and Dynamed.

Through the guidance of the family clerkship professors, it was observed that the third year medical students, previously unfamiliar with utilizing point of care resources, became more familiar and initiated the application of EBM to the hypothetical cases by the third week. It demonstrated the importance of FIF to help students maintain the EBM thought process outside of the classroom, and the need to reinforce the framework during their clinical rotations.

From the meetings with the EBM-VIG, the research team understood that FIF was to serve as an educational tool in order to guide medical students through the EBM process. Given that this is the goal, the research team was to maintain the same goals in the app design.
II. APPLICATION RESEARCH

The limited screen size of a smartphone is an inherent problem with small devices, and needed to be kept in mind during the development of the app. The application was developed natively as a mobile app instead of a web-based app, as it allowed more customizable features to make the app more interactive for the user (Nolan, Cinar, & Truxall, 2014). In addition to the popularity among users utilizing a mobile app compared to a web-based app, the flexibility in creating a mobile app allowed for designs that were the best fit for our targeted audience.

There were four main properties in a mobile design that appealed to users. Therefore, the research team kept the following concepts in mind during the design of the app: ease of use, usefulness from a user’s perspective, customization, and perceived attractiveness (Li & Yeh, 2010). These all had to be included and designed within a limited display.

Using Balsamiq, the research team designed the layout of the app from screen to screen including the most user-friendly features from previously published literature (Figure 2). Balsamiq allowed both the research team and the programmers from GAI to be in agreement of the layout of the app.
Figure 2. Complete wireframe of FIF using Balsamiq. The wireframe provides a layout of how the app interacts with a user. Designed and created by BUSM’s research team.
STRUCTURAL DESIGN

i. SPLASH SCREEN - The app was built with limited reliance on network access. Therefore, upon downloading the app, the user would be able to navigate through the app to discover the necessary resources. Similar to many apps, there is a lag time as the app loads before it can be utilized. Users frequently need a visual aid to signify that the app is loading once they open it (Nolan et al., 2014). Therefore, a splash screen was incorporated as a signal to the user after careful discussion between the research team and the GAI members (Figure 3A).

i. BUTTONS - A button design was chosen so that there would be a constant user interface. This was recognized as important, as it gives the user a feeling of involvement in the process and requires concentration to complete the task (Buchinger, Kriglstein, Brandt, & Hlavacs, 2011). The buttons need to be designed reasonably large and spaced at an equal and far enough distance apart from each other, as to minimize errors (Choi, et al, 2012). Since smartphones rely on touch input by fingertips instead of accurate mouse control, it was important to minimize errors in order to maintain user satisfaction. Therefore, the size of the buttons on the app was built for the universal user.

ii. REFERENCE FEATURE - The initial question in the framework was the starting point and served as the home page. Since the users would be expected to utilize the app outside of BUSM, there was a need to incorporate the definitions and examples of each term so that the user would be familiar with the categories, and be able to make educated decisions as they navigate the app (Figure 4).
Additionally, there were several cognitive perceptions that influence users, specifically exploratory behavior and performance gains (Buchinger et al., 2011). This was defined as the ability for users to spontaneously explore a mobile application without prior instruction and increase user’s ability to solve the task.

In order to address these behaviors, the research team built features for users to access the concept of FIF and definitions of the categories. The information button was placed next to each new category for an easy click to the definitions and examples that were be linked to a different page (Figure 3B and 3C). There were several categories in the app that were not defined due to the EBM-VIG identifying such categories as self-explanatory. All categories, however, had examples to serve the user as references.
Figure 3. Screenshot from Balsamiq of the Layout of FIF. Each screen has been labeled A (splash screen), B (bar to four buttons: home, back, complete FIF screen, and information and history of FIF), and C (Background sample screen). Created and designed by BUSM’s research team.
**Background Questions**

Definition: Ask for general knowledge about a process, condition, test, treatment, or thing. The who, what, where, when, why, how of a ____ (disorder, test, treatment, pathway, etc.).

Example: What is the mechanism that causes peripheral edema in liver cirrhosis?

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**Figure 4. Definition and Example of a Background Category in FIF.** Each new category provided a definition and example as a reference for the student. Sample provided by the EBM-VIG.

iii. TOOL BAR - Users have identified from previously published apps that a tool bar located on the screen allowed them to navigate easily from one screen to the next, and maintained consistency throughout the app (Buchinger et al., 2011). There were restrictions, however, to the size and number of tools to include due to the small screen size, and risk of confusion and poor usability from a cluttered interface.

Hence, the tool bar was limited to four buttons: Home, Back, Complete FIF screen, and Information and History of FIF (Figure 3B and 3C). Since the goal of FIF was to help train students to master finding the information pertaining to EBM, the EBM-VIG did not want a student to skip ahead to the resources. Therefore, the research team maintained that goal by removing the ability to skip to the final categories. The web-version of the complete FIF was added to the app to serve as a reference for students. The information and history of FIF tool provided the user with background information, and a contact in the event of any questions or issues arose regarding the app.
iv. LIVE LINKS – The app needed to mimic as much of the FIF web-version as was allowed on a mobile device display. Although the initial intention was for the app to be independent of Internet connection, the ease and direct accessibility of information resources from the app would improve the user interface. Therefore, at the end of each category the resources linked directly to the necessary webpages, from Blackboard Learn to direct EBM resources following a BU’s Kerberos login (Table 2). Regardless, the user would still be able to use the tools of the app, which served the purpose of FIF to locate the resources to utilize despite a lack of Internet connection.
Table 2. List of e-Information Resources in FIF. The following is a list of all the possible resources that a user would be directed to from the FIF.

<table>
<thead>
<tr>
<th>Information Resources Listed in FIF</th>
<th>Web Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabi</td>
<td><a href="http://www.learn.bu.edu">www.learn.bu.edu</a></td>
</tr>
<tr>
<td>Textbooks</td>
<td><a href="http://www.medlib.bu.edu/ebooks/">www.medlib.bu.edu/ebooks/</a></td>
</tr>
<tr>
<td>UpToDate</td>
<td><a href="http://www.uptodate.com/contents/search">www.uptodate.com/contents/search</a></td>
</tr>
<tr>
<td>Laboratory / Testing</td>
<td><a href="http://www.medlib.bu.edu/webcollections/subject.cfm?id=67">www.medlib.bu.edu/webcollections/subject.cfm?id=67</a></td>
</tr>
<tr>
<td>Clinical Queries</td>
<td>www-ncbi.nlm.nih.gov.ezproxy.bu.edu/pubmed/clinical</td>
</tr>
<tr>
<td>Dynamed</td>
<td><a href="http://web.b.ebscohost.com.ezproxy.bu.edu/dynamed/search/basic?sid=bf24ba76-0d4d-4046-844b-6ff68fd8fbdc%40sessionmgr111&amp;vid=1&amp;hid=117">http://web.b.ebscohost.com.ezproxy.bu.edu/dynamed/search/basic?sid=bf24ba76-0d4d-4046-844b-6ff68fd8fbdc%40sessionmgr111&amp;vid=1&amp;hid=117</a></td>
</tr>
<tr>
<td>ePSS (USPSTF)</td>
<td><a href="http://epss.ahrq.gov/ePSS/index.jsp">http://epss.ahrq.gov/ePSS/index.jsp</a></td>
</tr>
<tr>
<td>Natural Standard</td>
<td><a href="http://www.naturalstandard.com.ezproxy.bu.edu/">http://www.naturalstandard.com.ezproxy.bu.edu/</a></td>
</tr>
<tr>
<td>CDC</td>
<td><a href="http://www.cdc.gov/">http://www.cdc.gov/</a></td>
</tr>
<tr>
<td>Department of Public Health</td>
<td><a href="http://www.hhs.gov/">http://www.hhs.gov/</a></td>
</tr>
<tr>
<td>Community Agencies / Resources</td>
<td><a href="http://blogs.bu.edu/buatp/resources-2/clinical-resources/">http://blogs.bu.edu/buatp/resources-2/clinical-resources/</a></td>
</tr>
</tbody>
</table>
v. VISUAL CUES - As the app was being developed, the research team met with the EBM-VIG on February 24, 2014. An EBM-VIG member, Dr. John Wichita, mentioned that through the original navigation of the framework that the overall concept may be lost on the student. Based on the web-version, a student can see the larger picture easily by seeing how one category is related to another.

Due to the limitation in screen size, however, it was difficult to incorporate that concept into the app in the same manner as a web page. Therefore, the structural design was updated to include several features. The category that each question referred to was bolded and capitalized within the question to serve as a visual cue to the reader. Subsequent subcategories were also bolded and capitalized, but the previous category would remain in a grey text above to illustrate a previous step and reminder for the user (Figure 5). This idea stemmed from the importance of visual cues and how it helped users recognize important concepts immediately (Choi & Lee, 2012). The visual cues can vary from text design, background images, layout, and navigation tools. In this instance, the app focused on text design.
Figure 5. Updated Layout of the App to Incorporate the Overarching Concept of FIF. A visual cue is included at the top of the screen to signal the navigation of the framework to the user. Each screen has been labeled A (Clinical sample screen) and B (Rare / Academic Interest final category sample screen). Created and designed by BUSM’s research team.

In order to prevent further confusion for the user, a carrot navigation was added at the top of the screen to reiterate the navigation through the framework. Specifically, as seen in the example above (Figure 5), screen B would denote “Background > Clinical >” at the top of the screen instead of a vertical layout (Figure 6). Since confusion is a serious concern regarding smartphones, due to the fact that the duration of each task is
relatively short, the research team kept the simplicity of key features of highest importance in the app design.

**Figure 6. Screenshot of Basic Science Detailed Resources Page of FIF.** The figure highlights the carrot navigation at the top of the screen to signal to the user the process to arrive at the basic science detailed resources.

**VISUAL DESIGN**

There were classical designs that were necessary to be visually aesthetic to a user. These include: clarity, organization, uniformity, grouping, simplicity, balance, and symmetry (Choi & Lee, 2012). More importantly, to increase “attractiveness” to users, there were other factors including: originality, creativity, and special effects (Choi & Lee,
The research team took these factors into considerations when designing the visual layout of the app.

i. LOGO – Logos communicate identification of a product and require simplicity, easy recognition and recall, and reproducibility (Macario, 2009). In creating a logo for FIF, the research team explored a logo that captured the mastery of finding information through medical education. A successful logo expresses a multifaceted message through a minimal, unique symbol (Macario, 2009). Therefore, the team identified the lowercase “i” as a commonly recognized symbol to denote information. The team used the Chalkduster font to help emphasize FIF as a means of education. The special effects added on the logo, including shading to give the illusion of a 3D effect, which offered a visual richness that provided an added stimulus to the viewer and further captured the button navigation of the app (Figure 7).

Figure 7. FIF Logo Version A. Created and designed by BUSM’s research team.
An alternative logo was included below, as it was created by the GAI design team. The logo highlights a lot of unique features and simplicity that published literature have discussed. It will be utilized by the GAI in programming the mobile app (Figure 8).

**Figure 8. FIF Logo Version B.** Created and designed by GAI.

ii. SPLASH SCREEN – In order to signal to the user that the app was loading, the research team and GAI members felt that this screen was necessary. The design was created by the GAI’s design team with the research team to include the value of technology to assist in the mastery of finding information (Figure 9).
iii. **COLOR SCHEME** – As the app was intended for the medical community, the color needed to emit professionalism and integrity. Therefore, the app utilized varying shades of blue, as it suggested expertise, authority, seriousness of purpose, honesty and cleanliness (Macario, 2009).

iv. **TYPEFACE** – There has been low user rating of apps with small font size, as it is difficult to read and perceived to be of low quality (Buchinger et al., 2011). The size of the font was chosen to be moderately sized, relative to the screen size and static features on the app (i.e. tool bar and logo). A sans-serif typeface was
chosen as it was perceived as a more casual style and the mono-weight lines were more legible on screens (Macario, 2009).
DISCUSSION

Through the research of mobile app designs and user interface, the research team was able to design and build an EBM mobile app for medical education. Once the app is published in both the iTunes App store and Google Play, the next step will be to test the ease and usability of the app by medical students at BUSM. The app although is based on research that discussed the best practice, it has not been tested by medical students nor BUSM faculty. Thus, focus groups with faculty need to be conducted to receive larger input on how best to implement the app into more of the medical curricula. Additionally, the focus groups will generate more discussion and interest surrounding FIF, and more buy-in from the faculty. It will also be important to conduct surveys to test how user-friendly the app is for the intended audience.

In the future, it will be of interest to test the app on medical students in the various stages of their training, and compare the findings to see whether their performance is affected by when they were introduced to the app and the duration of utilization. Initially, overall feedback on the design and ease of use with BUSM IV students will be collected. These students will have already transitioned into the clinical years without the benefit of the app. Feedback initially from them will help to inform on how, and possibly when, the app should be introduced into BUSM curriculum. Next, the app will be piloted in BUSM III students as they transition between Year II and Year III. It will likely also be piloted in incoming first year Family Medicine residents that have been trained at an institution other than BUSM to assure they understand and utilize the
EBM model approach that BUSM teaches. These studies will provide qualitative results of the outcome and usefulness in using an EBM app in their training and in applying it to practice. A key concern in the future will be to decide who will maintain and upgrade the app when new versions of the iOS and Android are produced, and assist in the transition to a tablet interface. Additionally, if any lingering bugs existed with the current model, a point person should be designated to diagnose and fix the problem.

In order to continually improve the app, it is necessary to incorporate user feedback throughout future developments and updates to customize the app to fit the needs of the BUSM community (Hahn & Morales, 2011). There were several alternative designs that may be more modern and could apply to future versions of FIF, but presently were not included as it exceeded the capabilities and time constraints of GAI. These designs included a swipe function to pull a drop down menu, instead of a static tool bar at the bottom. Additionally, a splash screen that had a moving display to signal that the app was loading instead of a static screen. Furthermore, physicians and medical students have praised an annotation feature on medical apps, so that they can take notes on resources that they found valuable and might want to refer to in the future. Another possible feature includes the ability for the user to converse through a forum on the app with other medical students. It has been identified that users want the opportunity to generate content and share it with others (Buchinger et al., 2011).

Due to the limitations of our resources, the research team relied on GAI to help code and program the app. GAI, a club of full-time undergraduates students, who volunteer also created some limitations in the research. Since the research team did not
have a hired engineering team to dedicate set times to the app, there were limitations as to when GAI would deliver the app. Additionally, there were other limitations, such as how much could be asked of the club members, as they volunteered their time and also had limited skills in coding apps. The research team acknowledged the experience and knowledge of the GAI members, and took their input into account as well during the designing stage. It is through them that we were able to have a logo that was approved by the EBM-VIG.
CONCLUSION

As medicine continues to grow and change, physicians need to adapt in order to remain updated. As medical education evolves to address the growth in medicine through EBM, there is a need to support these changes. Since EBM is included in more medical school curricula, there is a need to reinforce the concepts learned. The FIF tool was developed to help guide students to access and master accessing the resources to aid in the application of EBM.

Several studies have identified that the usability of apps influence user ratings. The app included several features that were believed to increase the interactivity and usability of FIF. Some of these features included a tool bar, button design, sans-serif typeface, and a blue color theme.

The research team, which included members from the Graduate of Medical Sciences collaborated with multiple schools at Boston University including BUSM and BU’s School of Electrical and Computer Engineering and College of Fine Arts to develop an iOS and Android mobile app called FIF.
APPENDIX

Exhibit A. Android Code for FIF

AndroidManifest.xml

<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.example.fif"
    android:versionCode="1"
    android:versionName="1.0">  

<uses-sdk
    android:minSdkVersion="10"
    android:targetSdkVersion="18"/>

<application
    android:allowBackup="true"
    android:debuggable="true"
    android:icon="@drawable/ic_launcher"
    android:label="@string/app_name"
    android:theme="@style/Theme.AppCompat.Light">
    <activity
        android:name="com.example.fif.MainActivity"
        android:label="FiF">
        <intent-filter>
            <action android:name="android.intent.action.MAIN" />
            <category android:name="android.intent.category.LAUNCHER" />
        </intent-filter>
    </activity>
    <activity
        android:name="com.example.fif.myMainScreen"
        android:label="@string/app_name">
        <intent-filter>
            <action android:name="com.tutorial.CLEARSCREEN" />
        </intent-filter>
    </activity>
    <activity
        android:name="com.example.fif.Foreground"
        android:label="@string/title_activity_foreground">
    </activity>
    <activity
        android:name="com.example.fif.Background"
        android:label="@string/title_activity_background">
    </activity>
    <activity
        android:name="com.example.fif.Resources"
        android:label="@string/title_activity_resources">

    </activity>
</application>
</manifest>
<activity>
    android:name="com.example.fif.PointOfCare"
    android:label="@string/title_activity_point_of_care">
</activity>
<activity>
    android:name="com.example.fif.Clinical"
    android:label="@string/title_activity_clinical">
</activity>
<activity>
    android:name="com.example.fif.Basic_Science"
    android:label="@string/title_activity_basic__science">
</activity>
<activity>
    android:name="com.example.fif.Rare_F"
    android:label="@string/title_activity_rare__f">
</activity>
<activity>
    android:name="com.example.fif.Rare_B"
    android:label="@string/title_activity_rare__b">
</activity>
<activity>
    android:name="com.example.fif.Common"
    android:label="@string/title_activity_common">
</activity>
<activity>
    android:name="com.example.fif.Info_page"
    android:label="@string/title_activity_info_page" 
</activity>
<activity>
    android:name="com.example.fif.Map_page"
    android:label="@string/title_activity_map_page" 
</activity>
<activity>
    android:name="com.example.fif.LiteratureSearch"
    android:label="@string/title_activity_literature_search" 
</activity>
<activity>
    android:name="com.example.fif.BackgroundInfo"
    android:label="@string/title_activity_background_info" 
</activity>
<activity>
    android:name="com.example.fif.ForegroundInfo"
    android:label="@string/title_activity_foreground_info" 
</activity>
<activity>
    android:name="com.example.fif.Basic_ScienceInfo"
    android:label="@string/title_activity_basic__science_info" 
</activity>
<activity>
    android:name="com.example.fif.ClinicalInfo"
    android:label="@string/title_activity_clinical_info" 
</activity>
<activity>
    android:name="com.example.fif.CommonInfo"
    android:label="@string/title_activity_common_info" >
</activity>
<activity>
    android:name="com.example.fif.Rare_BInfo"
    android:label="@string/title_activity_rare__binfo" >
</activity>
<activity>
    android:name="com.example.fif.Rare_FInfo"
    android:label="@string/title_activity_rare__finfo" >
</activity>
<activity>
    android:name="com.example.fif.PointOfCareInfo"
    android:label="@string/title_activity_point_of_care_info" >
</activity>
<activity>
    android:name="com.example.fif.ResourcesInfo"
    android:label="@string/title_activity_resources_info" >
</activity>
</application>

</manifest>
Exhibit B. iOS Code for FIF

// !$*UTF8*$!
{
    archiveVersion = 1;
    classes = {
    }
    objectVersion = 46;
    objects = {

    /* Begin PBXBuildFile section */
    0ADEA43618AF12E300514B53 /* Foundation.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43518AF12E300514B53 /* Foundation.framework */; }
    0ADEA43818AF12E300514B53 /* CoreGraphics.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43718AF12E300514B53 /* CoreGraphics.framework */; }
    0ADEA43A18AF12E300514B53 /* UIKit.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43918AF12E300514B53 /* UIKit.framework */; }
    0ADEA44018AF12E300514B53 /* InfoPlist.strings in Resources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43E18AF12E300514B53 /* InfoPlist.strings */; }
    0ADEA44218AF12E300514B53 /* main.m in Sources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43518AF12E300514B53 /* Foundation.framework */; }
    0ADEA44618AF12E300514B53 /* AppDelegate.m in Sources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43918AF12E300514B53 /* UIKit.framework */; }
    0ADEA44918AF12E300514B53 /* Main.storyboard in Sources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43E18AF12E300514B53 /* InfoPlist.strings */; }
    0ADEA44C18AF12E300514B53 /* ViewController.m in Sources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA44B18AF12E300514B53 /* ViewController.m */; }
    0ADEA44E18AF12E300514B53 /* Images.xcassets in Resources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA44D18AF12E300514B53 /* Images.xcassets */; }
    0ADEA45518AF12E300514B53 /* XCTest.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA45418AF12E300514B53 /* XCTest.framework */; }
    0ADEA45618AF12E300514B53 /* Foundation.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43518AF12E300514B53 /* Foundation.framework */; }
    0ADEA45718AF12E300514B53 /* UIKit.framework in Frameworks */ =
    {isa = PBXBuildFile; fileRef = 0ADEA43918AF12E300514B53 /* UIKit.framework */; }
    0ADEA45F18AF12E300514B53 /* InfoPlist.strings in Resources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA45D18AF12E300514B53 /* InfoPlist.strings */; }
    0ADEA46118AF12E300514B53 /* FiFTests.m in Sources */ =
    {isa = PBXBuildFile; fileRef = 0ADEA46018AF12E300514B53 /* FiFTests.m */; }
    /* End PBXBuildFile section */

    /* Begin PBXContainerItemProxy section */
    0ADEA45818AF12E300514B53 /* PBXContainerItemProxy */ =
    {isa = PBXContainerItemProxy;
      containerPortal = 0ADEA42A18AF12E300514B53 /* Project object */
    }
    proxyType = 1;
    remoteGlobalIDString = 0ADEA43118AF12E300514B53;
    remoteInfo = FiF;
    }

}
/* End PBXContainerItemProxy section */

/* Begin PBXFileReference section */
0ADEA43218AF12E300514B53 /* FiF.app */ = {isa = PBXFileReference; explicitFileType = wrapper.application; includeInIndex = 0; path = FiF.app; sourceTree = BUILT_PRODUCTS_DIR; }
0ADEA43518AF12E300514B53 /* Foundation.framework */ = {isa = PBXFileReference; lastKnownFileType = wrapper.framework; name = Foundation.framework; path = System/Library/Frameworks/Foundation.framework; sourceTree = SDKROOT; }
0ADEA43718AF12E300514B53 /* CoreGraphics.framework */ = {isa = PBXFileReference; lastKnownFileType = wrapper.framework; name = CoreGraphics.framework; path = System/Library/Frameworks/CoreGraphics.framework; sourceTree = SDKROOT; }
0ADEA43918AF12E300514B53 /* UIKit.framework */ = {isa = PBXFileReference; lastKnownFileType = wrapper.framework; name = UIKit.framework; path = System/Library/Frameworks/UIKit.framework; sourceTree = SDKROOT; }
0ADEA43D18AF12E300514B53 /* FiF-Info.plist */ = {isa = PBXFileReference; lastKnownFileType = text.plist.xml; path = "FiF-Info.plist"; sourceTree = "<group>"; }
0ADEA43F18AF12E300514B53 /* en */ = {isa = PBXFileReference; lastKnownFileType = text.plist.strings; name = en; path = en.lproj/InfoPlist.strings; sourceTree = "<group>"; }
0ADEA44118AF12E300514B53 /* main.m */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.objc; path = main.m; sourceTree = "<group>"; }
0ADEA44318AF12E300514B53 /* FiF-Prefix.pch */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.h; path = "FiF-Prefix.pch"; sourceTree = "<group>"; }
0ADEA44418AF12E300514B53 /* AppDelegate.h */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.h; path = AppDelegate.h; sourceTree = "<group>"; }
0ADEA44518AF12E300514B53 /* AppDelegate.m */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.objc; path = AppDelegate.m; sourceTree = "<group>"; }
0ADEA44818AF12E300514B53 /* Base */ = {isa = PBXFileReference; lastKnownFileType = file.storyboard; name = Base; path = Base.lproj/Main.storyboard; sourceTree = "<group>"; }
0ADEA44A18AF12E300514B53 /* ViewController.h */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.h; path = ViewController.h; sourceTree = "<group>"; }
0ADEA44B18AF12E300514B53 /* ViewController.m */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.objc; path = ViewController.m; sourceTree = "<group>"; }
0ADEA44D18AF12E300514B53 /* Images.xcassets */ = {isa = PBXFileReference; lastKnownFileType = folder.assetcatalog; path = Images.xcassets; sourceTree = "<group>"; }
0ADEA45318AF12E300514B53 /* FiFTests.xctest */ = {isa = PBXFileReference; explicitFileType = wrapper.cfbundle; includeInIndex = 0; path = FiFTests.xctest; sourceTree = BUILT_PRODUCTS_DIR; }
0ADEA45418AF12E300514B53 /* XCTest.framework */ = {isa = PBXFileReference; lastKnownFileType = wrapper.framework; name = XCTest.framework; path = Library/Frameworks/XCTest.framework; sourceTree = DEVELOPER_DIR; }
0ADEA45C18AF12E300514B53 /* FiFTests-Info.plist */ = {isa = PBXFileReference; lastKnownFileType = text.plist.xml; path = "FiFTests-Info.plist"; sourceTree = "<group>"; }
0ADEA45E18AF12E300514B53 /* en */ = {isa = PBXFileReference; lastKnownFileType = text.plist.strings; name = en; path = en.lproj/InfoPlist.strings; sourceTree = "<group>"; }
0ADEA46018AF12E300514B53 /* FiFTests.m */ = {isa = PBXFileReference; lastKnownFileType = sourcecode.c.objc; path = FiFTests.m; sourceTree = "<group>"; }
/* End PBXFileReference section */

/* Begin PBXFrameworksBuildPhase section */
/* Frameworks */ = {
  isa = PBXFrameworksBuildPhase;
  buildActionMask = 2147483647;
  files = (0ADEA43818AF12E300514B53 /* CoreGraphics.framework in Frameworks */)
  runOnlyForDeploymentPostprocessing = 0;
};
0ADEA43618AF12E300514B53 /* UIKit.framework in Frameworks */ = {
  isa = PBXFrameworksBuildPhase;
  buildActionMask = 2147483647;
  files = (0ADEA43618AF12E300514B53 /* Foundation.framework in Frameworks */)
  runOnlyForDeploymentPostprocessing = 0;
};
0ADEA45018AF12E300514B53 /* XCTest.framework in Frameworks */ = {
  isa = PBXFrameworksBuildPhase;
  buildActionMask = 2147483647;
  files = (0ADEA45518AF12E300514B53 /* XCTest.framework in Frameworks */)
  runOnlyForDeploymentPostprocessing = 0;
};
/* End PBXFrameworksBuildPhase section */
/* Begin PBXGroup section */
0ADEA42918AF12E300514B53 /* Frameworks */ = {
  isa = PBXGroup;
  children = (0ADEA43B18AF12E300514B53 /* FiF */)
  sourceTree = "<group>";
};
0ADEA43318AF12E300514B53 /* Products */ = {
  isa = PBXGroup;
  children = (0ADEA43218AF12E300514B53 /* FiF.app */)
  name = Products;
  sourceTree = "<group>";
};
0ADEA43418AF12E300514B53 /* Frameworks */ = {
  isa = PBXGroup;
  children = (0ADEA43518AF12E300514B53 /* FiFTests.xctest */)
};
Foundation.framework *,
CoreGraphics.framework *
UIKit.framework */,
XCTest.framework */,

name = Frameworks;
sourceTree = "<group>";

0ADEA43B18AF12E300514B53 /* FiF */ = {
    isa = PBXGroup;
    children = ( 
        0ADEA4418AF12E300514B53 /* AppDelegate.h */,
        0ADEA44518AF12E300514B53 /* AppDelegate.m */,
        0ADEA44718AF12E300514B53 /* Main.storyboard */,
        0ADEA44A18AF12E300514B53 /* ViewController.h */,
        0ADEA44B18AF12E300514B53 /* ViewController.m */,
        0ADEA44D18AF12E300514B53 /* Images.xcassets */,
        0ADEA43C18AF12E300514B53 /* Supporting Files */,
    );
    path = FiF;
    sourceTree = "<group>";
};

0ADEA43C18AF12E300514B53 /* Supporting Files */ = {
    isa = PBXGroup;
    children = ( 
        0ADEA43D18AF12E300514B53 /* FiF-Info.plist */,
        0ADEA43E18AF12E300514B53 /* InfoPlist.strings */,
        0ADEA4418AF12E300514B53 /* main.m */,
        0ADEA44318AF12E300514B53 /* FiF-Prefix.pch */,
    );
    name = "Supporting Files";
    sourceTree = "<group>";
};

0ADEA45A18AF12E300514B53 /* FiFTests */ = {
    isa = PBXGroup;
    children = ( 
        0ADEA46018AF12E300514B53 /* FiFTests.m */,
        0ADEA45B18AF12E300514B53 /* Supporting Files */,
    );
    path = FiFTests;
    sourceTree = "<group>";
};

0ADEA45B18AF12E300514B53 /* Supporting Files */ = {
    isa = PBXGroup;
    children = ( 
        0ADEA45C18AF12E300514B53 /* FiFTests-Info.plist */,
        0ADEA45D18AF12E300514B53 /* InfoPlist.strings */,
    );
    name = "Supporting Files";
sourceTree = "<group>";

/* End PBXGroup section */

/* Begin PBXNativeTarget section */
0ADEA43118AF12E300514B53 /* FiF */ = {
    isa = PBXNativeTarget;
    buildConfigurationList = 0ADEA46418AF12E300514B53 /* Build configuration list for PBXNativeTarget "FiF" */;
    buildPhases = (0ADEA42E18AF12E300514B53 /* Sources */, 0ADEA42F18AF12E300514B53 /* Frameworks */, 0ADEA43018AF12E300514B53 /* Resources */, );
    buildRules = ();
    dependencies = ();
    name = FiF;
    productName = FiF;
    productReference = 0ADEA43218AF12E300514B53 /* FiF.app */;
    productType = "com.apple.product-type.application";
};
0ADEA45218AF12E300514B53 /* FiFTests */ = {
    isa = PBXNativeTarget;
    buildConfigurationList = 0ADEA46718AF12E300514B53 /* Build configuration list for PBXNativeTarget "FiFTests" */;
    buildPhases = (0ADEA44F18AF12E300514B53 /* Sources */, 0ADEA45018AF12E300514B53 /* Frameworks */, 0ADEA45118AF12E300514B53 /* Resources */, );
    buildRules = ();
    dependencies = (0ADEA45918AF12E300514B53 /* PBXTargetDependency */, );
    name = FiFTests;
    productName = FiFTests;
    productReference = 0ADEA45318AF12E300514B53 /* FiFTests.xctest */;
    productType = "com.apple.product-type.bundle.unit-test";
};
/* End PBXNativeTarget section */

/* Begin PBXProject section */
0ADEA42A18AF12E300514B53 /* Project object */ = {
    isa = PBXProject;
    attributes = {
        LastUpgradeCheck = 0500;
        ORGANIZATIONNAME = "Marika Lee";
    };
/* End PBXProject section */
TargetAttributes = {
    0ADEA45218AF12E300514B53 = {
        TestTargetID =
    };
};
buildConfigurationList = 0ADEA42D18AF12E300514B53 /* Build configuration list for PBXProject "FiF" */;
compatibilityVersion = "Xcode 3.2";
developmentRegion = English;
hasScannedForEncodings = 0;
knownRegions = (en, Base,);
mainGroup = 0ADEA42918AF12E300514B53;
productRefGroup = 0ADEA43318AF12E300514B53 /* Products */;
projectDirPath = "";
projectRoot = "";
targets = (0ADEA43118AF12E300514B53 /* FiF */, 0ADEA45218AF12E300514B53 /* FiFTests */,);
/* End PBXProject section */

/* Begin PBXResourcesBuildPhase section */
0ADEA43018AF12E300514B53 /* Resources */ = {
    isa = PBXResourcesBuildPhase;
    buildActionMask = 2147483647;
    files = (0ADEA44E18AF12E300514B53 /* Images.xcassets in Resources */, 0ADEA44018AF12E300514B53 /* InfoPlist.strings in Resources */, 0ADEA44918AF12E300514B53 /* Main.storyboard in Resources */,);
    runOnlyForDeploymentPostprocessing = 0;
};
0ADEA45118AF12E300514B53 /* Resources */ = {
    isa = PBXResourcesBuildPhase;
    buildActionMask = 2147483647;
    files = (0ADEA45F18AF12E300514B53 /* InfoPlist.strings in Resources */,);
    runOnlyForDeploymentPostprocessing = 0;
};
/* End PBXResourcesBuildPhase section */
/* Begin PBXSourcesBuildPhase section */
0ADEA42E18AF12E300514B53 /* Sources */ = {
    isa = PBXSourcesBuildPhase;
    buildActionMask = 2147483647;
    files = (
        0ADEA44C18AF12E300514B53 /* ViewController.m in Sources */;
        0ADEA44618AF12E300514B53 /* AppDelegate.m in Sources */;
        0ADEA44218AF12E300514B53 /* main.m in Sources */;
    );
    runOnlyForDeploymentPostprocessing = 0;
};
0ADEA44F18AF12E300514B53 /* Sources */ = {
    isa = PBXSourcesBuildPhase;
    buildActionMask = 2147483647;
    files = (
        0ADEA46118AF12E300514B53 /* FiFTests.m in Sources */;
    );
    runOnlyForDeploymentPostprocessing = 0;
};
/* End PBXSourcesBuildPhase section */

/* Begin PBXTargetDependency section */
0ADEA45918AF12E300514B53 /* PBXTargetDependency */ = {
    isa = PBXTargetDependency;
    target = 0ADEA43118AF12E300514B53 /* FiF */;
    targetProxy = 0ADEA45818AF12E300514B53 /* PBXContainerItemProxy */;
};
/* End PBXTargetDependency section */

/* Begin PBXVariantGroup section */
0ADEA43E18AF12E300514B53 /* InfoPlist.strings */ = {
    isa = PBXVariantGroup;
    children = (0ADEA43F18AF12E300514B53 /* en */);
    name = InfoPlist.strings;
    sourceTree = "<group>";
};
0ADEA44718AF12E300514B53 /* Main.storyboard */ = {
    isa = PBXVariantGroup;
    children = (0ADEA44818AF12E300514B53 /* Base */);
    name = Main.storyboard;
    sourceTree = "<group>";
};
0ADEA45D18AF12E300514B53 /* InfoPlist.strings */ = {
    isa = PBXVariantGroup;
}
children = (0ADEA45E18AF12E300514B53 /* en */,
);
name = InfoPlist.strings;
sourceTree = "<group>";

/* End PBXVariantGroup section */

/* Begin XCBuildConfiguration section */
0ADEA46218AF12E300514B53 /* Debug */ = {
    isa = XCBuildConfiguration;
    buildSettings = {
        ALWAYS_SEARCH_USER_PATHS = NO;
        ARCHS = "$\{ARCHS\_STANDARD\_INCLUDING\_64\_BIT\}\";
        CLANG_CXX\_LANGUAGE\_STANDARD = "\$\{ARCHS\_STANDARD\_INCLUDING\_64\_BIT\}\";
        "\$\{ARCHS\_STANDARD\_INCLUDING\_64\_BIT\}\";
        CLANG_CXX\_LIBRARY = "libc++";
        CLANG\_ENABLE\_MODULES = YES;
        CLANG\_ENABLE\_OBJC\_ARC = YES;
        CLANG\_WARN\_BOOL\_CONVERSION = YES;
        CLANG\_WARN\_CONSTANT\_CONVERSION = YES;
        CLANG\_WARN\_DIRECT\_OBJC\_ISA\_USAGE = YES_ERROR;
        CLANG\_WARN\_EMPTY\_BODY = YES;
        CLANG\_WARN\_ENUM\_CONVERSION = YES;
        CLANG\_WARN\_INT\_CONVERSION = YES;
        CLANG\_WARN\_OBJC\_ROOT\_CLASS = YES_ERROR;
        CLANG\_WARN\_DUPLICATE\_METHOD\_MATCH = YES;
        "CODE\_SIGN\_IDENTITY\[sdk=iphoneos\]*" = "iPhone Developer";
        COPY\_PHASE\_STRIP = NO;
        GCC\_C\_LANGUAGE\_STANDARD = gnu99;
        GCC\_OPTIMIZATION\_LEVEL = 0;
        GCC\_PREPROCESSOR\_DEFINITIONS = ("\$\{inherited\}",
            "$(inherited)"
        );
        GCC\_SYMBOLS\_PRIVATE\_EXTERN = NO;
        GCC\_WARN\_64\_TO\_32\_BIT\_CONVERSION = YES;
        GCC\_WARN\_ABOUT\_RETURN\_TYPE = YES_ERROR;
        GCC\_WARN\_UNDECLARED\_SELECTOR = YES;
        GCC\_WARN\_UNINITIALIZED\_AUTOS = YES;
        GCC\_WARN\_UNUSED\_FUNCTION = YES;
        GCC\_WARN\_UNUSED\_VARIABLE = YES;
        IPHONEOS\_DEPLOYMENT\_TARGET = 7.0;
        ONLY\_ACTIVE\_ARCH = YES;
        SDKROOT = iphoneos;
    };
};
name = Debug;

0ADEA46318AF12E300514B53 /* Release */ = {
    isa = XCBuildConfiguration;
    buildSettings = {
        ALWAYS_SEARCH_USER_PATHS = NO;
        ARCHS = "$\text{ARCHS\_STANDARD\_INCLUDING\_64\_BIT}\$";
        CLANG_CXX_LANGUAGE_STANDARD = "\text{gnu++0x}";
        CLANG_CXX_LIBRARY = "\text{libc++}";
        CLANG_ENABLE_MODULES = YES;
        CLANG_ENABLE_OBJC_ARC = YES;
        CLANG_WARN_BOOL_CONVERSION = YES;
        CLANG_WARN_CONSTANT_CONVERSION = YES;
        CLANG_WARN_DIRECT_OBJC_ISA_USAGE = YES_ERROR;
        CLANG_WARN_EMPTY_BODY = YES;
        CLANG_WARN_ENUM_CONVERSION = YES;
        CLANG_WARN_INT_CONVERSION = YES;
        CLANG_WARN_OBJC_ROOT_CLASS = YES_ERROR;
        CLANG_WARN__DUPLICATE_METHOD_MATCH = YES;
        CLANG_WARN_UNDECLARED_SELECTOR = YES;
        CLANG_WARN_UNUSED_FUNCTION = YES;
        CLANG_WARN_UNUSED_VARIABLE = YES;
        CODE_SIGN_IDENTITY[sdk=iphoneos*] = "iPhone Developer";
        COPY_PHASE_STRIP = YES;
        ENABLE_NS_ASSERTIONS = NO;
        GCC_C_LANGUAGE_STANDARD = gnu99;
        GCC_WARN_64_TO_32_BIT_CONVERSION = YES_ERROR;
        GCC_WARN_ABOUT_RETURN_TYPE = YES_ERROR;
        GCC_WARN_DEPRECATED = YES;
        GCC_WARN_UNUSED_FUNCTION = YES;
        GCC_WARN_UNUSED_INITIALIZER = YES;
        GCC_WARN_UNUSED_VARIABLE = YES;
        IPHONEOS_DEPLOYMENT_TARGET = 7.0;
        SDKROOT = iphoneos;
        VALIDATE_PRODUCT = YES;
    }
};
name = Release;

0ADEA46518AF12E300514B53 /* Debug */ = {
    isa = XCBuildConfiguration;
    buildSettings = {
        ASSETCATALOG_COMPILER_APPICON_NAME = AppIcon;
        ASSETCATALOG_COMPILER_LAUNCHIMAGE_NAME = LaunchImage;
        GCC_PRECOMPILE_PREFIX_HEADER = YES;
        GCC_PREFIX_HEADER = "FiF/FiF-Prefix.pch";
    }
}
BUNDLE_LOADER =
"$(BUILT_PRODUCTS_DIR)/FiF.app/FiF";
FRAMEWORK_SEARCH_PATHS = ( $(SDKROOT)/Developer/Library/Frameworks",
(inherited)",
$(DEVELOPER_FRAMEWORKS_DIR),
);
GCC_PRECOMPILE_PREFIX_HEADER = YES;
GCC_PREFIX_HEADER = "FiF/FiF-Prefix.pch";
INFOPLIST_FILE = "FiFTests/FiFTests-Info.plist";
PRODUCT_NAME = "$\{TARGET_NAME\}";
TEST_HOST = "$(BUNDLE_LOADER)";
WRAPPER_EXTENSION = xctest;
name = Release;

}/* End XCBuildConfiguration section */

}/* Begin XCConfigurationList section */

"FiF" */ = {
isa = XCConfigurationList;
buildConfigurations = ( 0ADEA42D18AF12E300514B53 /* Debug */,
0ADEA46218AF12E300514B53 /* Release */,
);
defaultConfigurationIsVisible = 0;
defaultConfigurationName = Release;

}:
0ADEA46418AF12E300514B53 /* Build configuration list for PBXNativeTarget "FiF" */ = {
isa = XCConfigurationList;
buildConfigurations = ( 0ADEA46218AF12E300514B53 /* Debug */,
0ADEA46318AF12E300514B53 /* Release */,
);
defaultConfigurationIsVisible = 0;

}:
0ADEA46718AF12E300514B53 /* Build configuration list for PBXNativeTarget "FiFTests" */ = {
isa = XCConfigurationList;
buildConfigurations = ( 0ADEA46518AF12E300514B53 /* Debug */,
0ADEA46618AF12E300514B53 /* Release */,
);
defaultConfigurationIsVisible = 0;

}:
/* End XCConfigurationList section */

rootObject = 0ADEA42A18AF12E300514B53 /* Project object */;
Main.storyboard

<?xml version="1.0" encoding="UTF-8" standalone="no"?>
toolsVersion="4451" systemVersion="13A461" targetRuntime="iOS.CocoaTouch"
propertyAccessControl="none" useAutolayout="YES" initialViewController="vXZ-lx-hvc">
  <dependencies>
    <plugIn identifier="com.apple.InterfaceBuilder.IBCocoaTouchPlugin" version="3676"/>
  </dependencies>
  <scenes>
    <scene sceneID="ufC-wZ-h7g">
      <objects>
        <viewController id="vXZ-lx-hvc" customClass="ViewController"
sceneMemberID="viewController">
          <view key="view" contentMode="scaleToFill" id="kh9-bI-dsS">
            <rect key="frame" x="0.0" y="0.0" width="320" height="568"/>
            <autoresizingMask key="autoresizingMask" flexibleMaxX="YES" flexibleMaxY="YES"/>
            <color key="backgroundColor" white="1" alpha="1" colorSpace="custom"
customColorSpace="calibratedWhite"/>
          </view>
</viewController>
<placeholder placeholderIdentifier="IBFirstResponder" id="x5A-6p-PRh" sceneMemberID="firstResponder"/>
    </objects>
  </scene>
  <simulatedMetricsContainer key="defaultSimulatedMetrics">
    <simulatedStatusBarMetrics key="statusBar"/>
    <simulatedOrientationMetrics key="orientation"/>
    <simulatedScreenMetrics key="destination" type="retina4"/>
  </simulatedMetricsContainer>
</document>
Applcon.appiconset/Contents.json

{
   "images" : [
   {
      "idiom" : "iphone",
      "size" : "29x29",
      "scale" : "2x"
   },
   {
      "idiom" : "iphone",
      "size" : "40x40",
      "scale" : "2x"
   },
   {
      "idiom" : "iphone",
      "size" : "60x60",
      "scale" : "2x"
   }
   ],
   "info" : {
      "version" : 1,
      "author" : "xcode"
   }
}

Launchimage.launchimage/Contents.json

{
   "images" : [
   {
      "orientation" : "portrait",
      "idiom" : "iphone",
      "extent" : "full-screen",
      "minimum-system-version" : "7.0",
      "scale" : "2x"
   },
   {
      "orientation" : "portrait",
      "idiom" : "iphone",
      "subtype" : "retina4",
      "extent" : "full-screen",
      "minimum-system-version" : "7.0",
      "scale" : "2x"
   }
   ],
   "info" : {
      "version" : 1,
      "author" : "xcode"
   }
}
Exhibit C. Complete Definitions and Examples of FIF. Provided by the EBM-VIG.

**Background Questions**
- Definition: Ask for **general knowledge** about a process, condition, test, treatment, or thing. The who, what, where, when, why, how of a ______ (disorder, test, treatment, pathway, etc.).
- Example: What is the mechanism that causes peripheral edema in liver cirrhosis?

**Foreground Questions**
- Definition: Ask for specific knowledge to **guide clinical decisions**. What treatment/test/medication/etc. to use in a specific clinical situation. Structured as PICO!
- Examples: In patient with acute coronary syndrome, do beta blockers, as compared to no beta blockers, decrease mortality? In diabetics with albuminuria and normal blood pressure, do ACE Inhibitors as compared to no pharmacotherapy decrease the need for dialysis or mortality rate?

**Basic Science Questions**
- Examples: How many FADH's will be produced by the metabolism of a single molecule of glutamate in the Krebs Cycle? Where is the insertion of the biceps brachii?

**Background → Clinical → Common Question**
- Examples: What are the types of oral medications available to treat diabetes? How do you classify asthma?

**Background → Clinical → Rare/Academic Interest Question**
- Example: What is Proteus Syndrome?

**Foreground → Rare / Academic Interest Question**
- Example: In patients with Whipple Disease, does antibiotic treatment decrease symptoms and reduce relapse rate?

**Foreground → Point-of-Care Question**
- Examples: In adults with diabetes, does metformin, as compared to sulfonylureas, decrease mortality? In patients with acute pericarditis, do NSAIDs, as compared to no treatment, hasten resolution of symptoms or decrease mortality?

**Foreground → Resources / Services**
- Examples: My patient is travelling to Angola. What vaccinations does she need? My patient is living in a shelter and needs dressing changes for a wound. What resources are available to help him? What is the prevalence of flu currently in my area?
REFERENCES


VITA

ANNIE LIU

Year of birth: 1985

Phone (646) 675 – 0389 | Email Aliu23@bu.edu

EDUCATION

Masters of Science and Masters of Arts, anticipated 2014

Boston University School of Medicine, Boston, MA

Boston University School of Public Health, Boston, MA

Medical Sciences and Public Health – Health Policy and Management

Bachelor of Science, 2007

Stonehill College, Easton, MA

Biochemistry

WORK EXPERIENCE

Harvard Vanguard Medical Associates, Boston, MA  2/2009- Present

Medical Assistant II, Internal Medicine Department  8/2007 - 9/2008

Led a team of medical assistants, directed LEAN projects, managed

inventory. Conducted office tests (Rapid streps, HCG, blood pressure,

EKG, quality control)

Stonehill College, Easton, MA

Teaching Assistant, Chemistry Department  2005 - 2007
Prepared and conducted weekly Physical Chemistry labs

Provided one on one tutoring help


Planned and implemented weekly review sessions for a class

Provided one on one tutoring


Tutor

Provided help for students in Chemistry, Biology, Human Anatomy and Physiology, Algebra, and Calculus

**RESEARCH EXPERIENCE**

Boston University School of Medicine, Boston, MA 8/2013- Present

Research Assistant, Family Clerkship

Study the best practice in the development of a mobile application for an Evidence Based Medicine framework.

**Summer Undergraduate Research Experience (SURE)**, Easton, MA 5/2006 - 8/2007

Research Assistant, Physical Chemistry

Studied heavy metals at a gas-liquid interface in a bubble column in efforts to remediate drinking water.

Presented research at American Chemical Society conference

Presented research at SURE conference and New England Environmental Symposium
Initially started as independent research at Stonehill College 5/2005 - 12/2005

VOLUNTEER EXPERIENCE

**Outreach Van Project**, Boston, MA Moving soup kitchen volunteer 1/2013 – 4/2013

**Rosie’s Place**, Boston, MA Food pantry volunteer 3/2012 – 5/2012

**Native Health Initiative (NHI)**, Albuquerque, NM Medical team intern 6/2009 - 7/2009

**Cycleage Technology, Inc.**, Mt. Kisco, NY Computer technician 2001 – 2005


LEADERSHIP EXPERIENCE/AWARDS

Harvard Vanguard Medical Associates Leadership Award 2012

Creative Nonfiction Excellence Award 2009

NHI Loving Service Award 2009

Certificate of Merit American Chemical Society 2007

Junior Leadership Award 2006

Treasurer of Chess Club 2003 – 2007

Secretary of Upperclassmen Student Mentor 2006 – 2007

Secretary of Biochemistry Club 2006 – 2007

Cultural Encounters Mentor 2004 – 2005