Building a Medical App: Approach, Infrastructure, and Challenges of Developing a CHD App for Educational Purposes

Alex Stoker[1], Randy Richardson[2], Timmy Garrabrant[3] , Brigham Willis[4]

[1]University of Arizona College of Medicine – Phoenix, AZ; [2]St. Joseph's Hospital and Medical Center, Phoenix, AZ; [3]Office of Instruction and Assessment, University of Arizona, Tucson, AZ; [4]Phoenix Children's Hospital, Phoenix, AZ

Abstract

Mobile software application (apps) have exploded in popularity since 2008, when Apple's App Store opened and have become increasingly present in medical education and medical practice. Congenital heart defects are the most common type of birth defect in the United States, affecting nearly 1% of, or about 40,000, births per year. There are complex three-dimensional relationships involved in many of the congenital heart defects that may be difficult for students to fully understand through the traditional method of reading and looking at two-dimensional diagrams.

The principle goal of this project was to participate in the design and development of an educational mobile app that allows the user to interactively rotate digital 3D models of hearts with congenital heart defects. Multiple approaches to developing an educational medical app were explored

This thesis aims to describe the resources available to develop an educational app, the major factors that determine the best approach for app development and the challenges associated with each approach. Through the case example of developing "Heart Defects" with the Office of Instruction and Assessment at the University of Arizona and publishing the app on the Apple App Store it was determined that the major factors guiding the approach to app development are complexity of the app, computer programming experience of the individual planning to develop an app, and having access to a larger institution with the ability to develop apps and the institution having a perceived benefit from developing the app.

Introduction

- Mobile software applications (Apps) have exploded in popularity since 2008, when Apple's App Store opened and have become a significant part of medical education and practice
- Congenital heart defects are the most common type of birth defect in the U.S, affecting nearly 1% or 40,000 births per year.
- Incidence of severe congenital heart defects requiring expert cardiologic care is 3 per 1000 live births.
- Congenital heart defects involve complex three-dimensional relationships that can be difficult for students to learn

GOALS:

- Participate in the design and development of an educational mobile app that allows the user to interactively rotate digital 3D models of hearts with congenital heart defects.
- Describe the available resources and approaches to developing a medical app

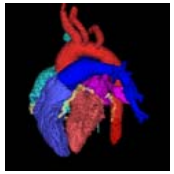

Fig 1. Image of one of the digital 3D models used in the "Heart Defects" app, which was created from a CT of an actual patient and shows real variation in human anatomy. All the models in the app use the same color-scheme to represent the different structures of the heart. This model shows a normal heart and is used as a reference when studying the various congenital heart defects included in the app.

Methods

- This project began with the idea of creating an educational app on congenital heart defects using existing 3D digital heart models
- Dr. Richardson had created a series of digital 3D heart models from CT scans of actual patients with congenital heart defects and utilized a color-coordinated system for easy visualization of the anatomy of the heart
- The potential approaches to developing a medical app were explored by Alex Stoker, a first-year medical student at UA COM – PHX at the start of the project

Timeline

- Jan – Feb 2013: First approach to app development attempted using free online app-building programs which do not require the user to perform any computer programming
- Feb-Mar 2013: Second approach attempted, rough blueprint of the app presented to several for-profit companies for professional development; average estimated cost quoted at $10,000
- Mar 2013: Contacted Michael Griffith, associate Director of biomedical communications at University of Arizona
- Apr 2013: Idea for the app presented to committee in the Office of Instruction and Assessment of the University of Arizona, Tucson, AZ and approved for development
- Jun-Jul 2013: Alex Stoker wrote the script and organized the content of the app into a "blueprint" for programmer Timmy Garrabrant
- Oct 2013: Web-based version of app completed
- Jan-July 2014: Feedback from content experts and students assembled to update app
- Oct 2014: The app entitled "Heart Defects" made available on the Apple App Store for free download

Results

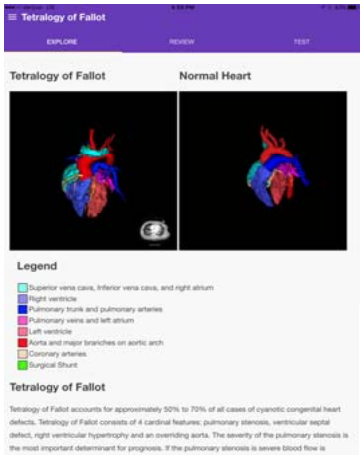

Fig 2. Screen shot of the "explore" section of the chapter on Tetralogy of Fallot in the app "Heart Defects". The heart model on the left is of a heart with Tetralogy of Fallot while the model on the right is a model of a normal heart. Touching the screen with a finger allows the user to rotate the models. Both models will simultaneously rotate and remain in the same orientation in order for the user to easily compare anatomy between the two hearts.

Fig. 3. Screen shot showing the list of chapters displayed on a drop down menu in the app "Heart Defect". This drop down menu appears on the left side of the screen when the user touches the list icon in the upper left hand corner.

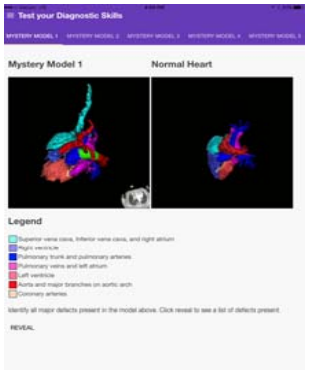

Fig 4. Screen shot of the chapter "test your diagnostic skills" in the app "Heart Defects". The user can rotate a "mystery model" alongside a normal heart to test their ability to identify all congenital heart defects in the model and then click on the "reveal" button to see a list of those defects present.

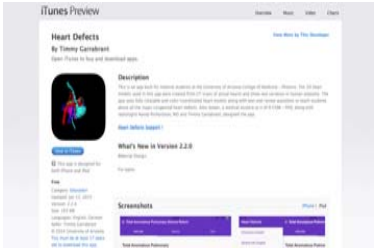

Fig 5. A screen shot showing the app "Heart Defects" description on the Apple App Store. The app is available for free download. The description of the app names the individuals involved in the design of the app and displays the copyright under the University of Arizona name.

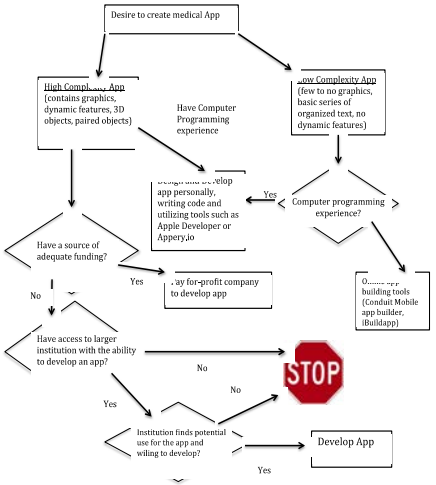

Fig. 6. Flow Chart of the approaches to building a medical app. This flowchart was developed from the experiences of developing "Heart Defects" as encountered by Alex Stoker.

Discussion and Conclusions

- Potential obstacles and Important factors to consider in order to select a successful approach to app development:
  - Complexity of the app
  - Level of funding for app development
  - Computer programming experience of individual planning app development
  - Having access to robust institution with available resources and a perceived benefit of developing the app
- Conclusions:
  - There is a growing emphasis on utilizing mobile apps in medical education and practice
  - A substantial infrastructure exists for creating medical apps and can be utilized by determined individuals with an idea for an app.
- Future Directions
  - Conduct survey to assess student preference on learning about CHDs through and interactive app compared to traditional method of looking at two-dimensional diagrams
  - Examine the effectiveness of the app, "Heart Defects" as a teaching tool by assessing student performance when aided by the App

Acknowledgements

- Randy Richardson, MD: for creating the digital 3D heart models used in the app.
- Mike Griffith: for his early interest in the project of creating a congenital heart defects app
- Timmy Garrabrant: for programming the app and helping to get the app onto the Apple App Store
- Brigham Willis, MD: For his contributions as a content expert
- Elaine Niggemann, MD: For her enthusiasm and for helping first year medical students at the University of Arizona College of Medicine – Phoenix utilize the congenital heart defects app