2016 Capstone Report

METALS HCII
Summer Report
Carnegie Mellon University

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EXECUTIVE SUMMARY

Western Governors University partnered with Slice Consulting, a team of four Master's students from Carnegie Mellon University, to design and prototype a micro-learning, mobile application. This app tightly integrates a mobile-first experience with the student experience of WGU's courses on the Acrobatiq platform. An important differentiation of this mobile app is a social feature, called Quiz-Off, where students can challenge a friend to answer a set of questions.

The Spring semester was dedicated to design. To gain a better understanding of the students and problem space, we conducted exploratory research consisting of a competitive analysis, literature reviews, interviews, flow models, and affinity diagrams. Following our research, we modeled and analyzed the data to generate a set of key insights, representative student profiles, and important design considerations. These results were then used to generate a set of nine feature ideas for the mobile application. From these nine features ideas, we hosted a visioning workshop at the end of Spring that integrated highlighted features into a coherent design. This design led us into the summer for implementation, building both an API on Acrobatiq's infrastructure and a prototype of the mobile app itself.

INTRODUCTION

CLIENT INTRODUCTION

Western Governors University

Western Governors University (WGU) is a private, nonprofit, online American university based in Salt Lake City, Utah. The university was founded by 19 U.S. governors in 1997 after the idea was formulated at a 1995 meeting of the Western Governors Association. The university uses a competency-based learning model, with students working online. WGU's accreditation is through the Northwest Commission on Colleges and Universities. WGU comprises four colleges, each offering bachelor's and master's degree programs: the College of Business, the College of Information Technology, the Teachers College, and the College of Health Professions, which includes degrees in nursing. Terms consist of six-month "rolling" semesters, which start for individual students on the first of every month. Classes are assigned unique terms lasting six weeks but students may proceed at their own pace. Many classes have cohorts, students working in the same general time frame, to facilitate online meetings and discussions, though students in any given cohort progress to the next course as soon as they are able to prove their knowledge. Course mentors provide both group and individual instruction as well as moderating online discussions. WGU also has student mentors who advise and guide a student throughout his or her entire degree program.

HUNT STATEMENT

WGU's most essential concern is to help students to stay in touch with the course content. Most of the students have very hectic schedules as they work full time and have other major responsibilities in life. Hence WGU wants to leverage mobile technology to increase engagement with the course content by building an application that supports micro learning or byte-size learning. Based on this description we came up with the following hunt statement for our project:

"EXPLORE STUDENT PERSONAL LEARNING DYNAMICS SO THAT WE CAN BUILD A SUPPORTING MOBILE APPLICATION IN WHICH STUDENTS CAN CONTINUOUSLY WORK TOWARDS THE LEARNING GOALS OF THEIR COURSES."

PROBLEM FORMULATION

Research Process

Our hunt statement informed our research process. In order to measure the personal learning dynamics of students, we decided to collect information on a variety of factors that can influence their learning strategies and behaviors. The students of WGU are spread throughout the United States and fall into a broad age group ranging from early 20s to mid 50s. Thus the research agenda needed to capture the learning dynamics of these students in order to identify issues that they face.

Although there is a heavy focus on learning outcomes, we have also emphasized the need for human centered design and its role in user experience. The research agenda as well as the design decisions have been influenced by both instrumental and non-instrumental values of the app. Thus the research process can be summarized as consisting of activities that help identify either the pragmatic aspects of behavior or the hedonic aspects of their behavior. The pragmatic aspect of user behavior typically refer to the behavioral goals for the product like increased engagement whereas the hedonic aspects refer to the stimulation, self-expression and self-maintenance (Hassenzahl & Tractinsky, 2006). [1]

"A product's novelty and the challenges it provides, for example, contribute to its hedonic quality, which is relevant because it promises fulfillment of an underlying human need – a need for being stimulated, to perfect one's skills and knowledge to grow" -- (Hassenzahl & Tractinsky, 2006)"

Competitive Analysis

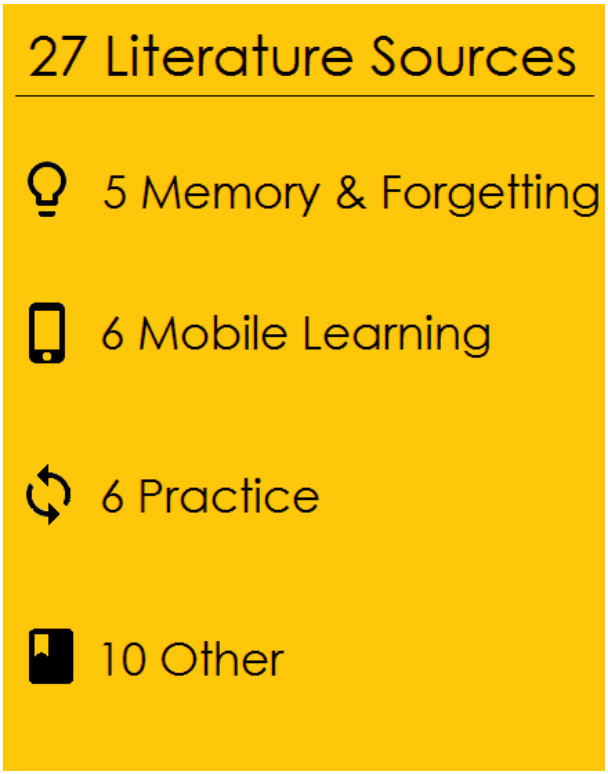
We conducted a two-part competitive analysis which focused on both mobile applications by other online universities and existing educational mobile applications targeted at the general consumer. Analyzing mobile applications implemented by competing online universities provided insights into what ultimately made them effective or ineffective. It also provided insights into how the students of the given university perceived the application's usefulness. In a similar vein, we wanted to see how existing third-party educational mobile applications effectively leveraged the use of learning science principles. This was used to gain design and implementation ideas constrained within a mobile device, while also helping to direct our literature review.

Online Universities

Educational Apps

Literature Review

Our literature review began by doing a broad overview of research related to learning in the context of a mobile application and ways to optimize time-constrained learning. From there we focused our review into these three major research areas: mobile learning, memory and forgetting, and spaced practice. Research on mobile learning literature helped to provide insights into the application of learning science principles and user-design considerations for a mobile application. Memory and forgetting are key cognitive areas that need to be addressed when dealing with retention and studying. Finally, research regarding spaced practice can be used to help inform how we can design the application to increase memory and fluency. Foundational ideas in these three research areas informed our modeling and further ideation in our design.



Interviews

Our Spring user-research was focused around interviews with WGU students. The interviews were a mixture of both in-person and online. We interviewed 25 participants ranging 26 to 61 years in age. The degree programs of these participants included accounting, business management, mathematics, educational leadership and IT. The number of years in the program ranges from 1 to 5 years. These participants came from a diverse range industries like software, medicine, education, milk processing, e-commerce, etc.

We began by conducting a series of in-person interviews, as we wanted a more personal experience with the WGU student. After conducting 5 in-person interviews, we revised our interview script to incorporate new findings, and proceeded with a series of online interviews. We conducted 20 online interviews, with additional iteration on the interview script as needed to focus on interesting insights that emerged (discussed in findings).

The interview questions mainly collected information on questions related to motivation behind joining the program or studying, study habits of individuals, how tech savvy the user, and their experience with WGU technology and WGU mentors.

Findings

Competitive Analysis

We looked at different mobile learning apps for online universities and discovered interesting similarities. We found that the existing mobile apps from different online universities were mainly geared towards administrative functions like sending messages, checking current and previous courses, university news or events. These apps often also had scheduling functionality and access to library resources. It was clear from this analysis that there is a big opportunity to make mobile apps that are more learning centered rather than administrative.

Our clients also wanted us to go in that direction as evident from the hunt statement which emphasized the design of a learning app that assists the students continuously with their coursework. A parallel analysis of the popular mobile learning apps revealed that had various built-in features for motivation and assistance with learning. This included push notifications and gamification for higher engagement to bite sized learning options and better interaction design for enhanced user experience. Thus, our competitive analysis and our client's vision for the app indicated that we need to keeping learning outcomes at the center of our design.

Literature review

Our literature review mainly focused on two areas, mobile learning and memory and forgetting. Mobile learning research focused on mobile learning frameworks or theories or tested empirical studies that could help us design for mobile experiences. One interesting framework is a mobility hierarchy given by Gay, Reiger & Bennington.[2] This hierarchy presents the This hierarchy presents the contrasting attributes of mobile devices.

The research on memory and forgetting revealed that, due to the phenomenon of retroactive interference, there should be higher importance given to protecting the newly formed memories than protecting the older ones; there is a need to strengthen memories to a point that they are immune to interference.

Techniques on improving memory of learned material have focused on spacing and chunking. Research on practice reveals that practices should be interleaved practice over massed practice. This means that we need to select material that is not limited by a course or topic but is spread throughout various courses.

Interview Findings

Our findings from interviews revealed that although WGU students benefited from and admired their current services, there was room for improvement on certain aspects of their experience. On the positive side, students got to study despite their hectic life and were able to enhance their careers. On the negative side, there were some logistical issues with their current website and students faced difficulty searching for and remembering where they saw the content earlier .

Students were also generally very positive about the coursework and design, however, for certain subject domains like mathematics there seemed to be a need for more assistance. This is understandable, as a lot of the times these students tend to have lost touch with their basics and need more help with how to solve questions. The user experience on student and course mentors was quite varied and ranged from the positive to the negative.

On the positive, mentors were helpful planning and scheduling the course better. They are also helpful in motivating the students to stay committed. On the negative side, the course mentors tend not to be very helpful with course related issues and students may feel no benefit in this interaction.

One of the central focuses of our hunt statement was on understanding learning dynamics of WGU students. We interviewed our subjects on their study habits and discovered vastly different methods and strategies. These strategies were often a result of a mixture of pragmatism for achieving their goals given the time constraints and beliefs about what is the best way to learn. Some students preferred reading the entire book and make notes about it while others prefer smaller bits. Some use flashcards or other tools to help themselves learn and revise, while others use more traditional methods to study. Overall, while the strategies varied a lot, the underlying need to perform well required them to engage with the course in a regular fashion.

Motivation plays an important role in setting and achieving goals. We found one of the two reasons as being the key motivation for pursuing the degree. For a lot of students getting a degree can have an effect on their career and WGU gives them a chance to get a degree that can help them with their professional goals. Some students, however, were in stable jobs and were not concerned with career prospects. The main motivation for such students was to get a degree for themselves or learning for internal satisfaction.

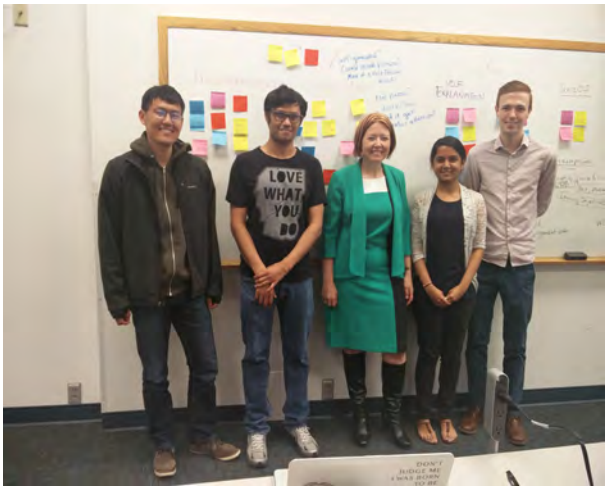
IDEATION

Visioning Workshop

We concluded the spring semester with a visioning workshop. During this workshop, we met with our WGU representatives, Jason Levin and Maria Anderson, along with several professors for Carnegie Mellon University. We presented our research and findings from the Spring semester and set out to narrow the scope of what we'd be pursuing during the summer. Our Spring work culminated in the formation of nine unique pitch ideas. Following our presentation, which included our nine ideas, we came together for a collaborative and hands on brainstorming session to narrow the scope down to a single pitch idea. This selected pitch, Quiz-Off, was our idea for socialized, trivia-style mobile app.

Selected Pitch Idea

The idea for Quiz-Off was initially spawned during one of our user tests toward the end of Spring semester. Part of these user interviews included a portion intended to gauge the user's mobile phone usage, including what existing applications they frequently interacted with. While we found that the majority of the interviewed users played at least one form of mobile game, we hadn't originally thought to capitalize on this behavior. That was until a particular user interview, when the participant said :



> "I play games on my phone all the time, I'd say I'm a fairly competitive person.."

This sparked a deeper discussion about their mobile game play habits, which led us to the realization that the students would make use of an educational mobile game.

Mobile games have been dominating the entertainment industry for the past several years. It seems everyone with a smartphone has at least one game they occasionally play on their phone. With Quiz-Off, users can satisfy their urge to have fun playing a mobile game, while also incorporating valuable study time! Quiz-Off is a mobile game where stu-dents face off against one another in a one vs. one trivia-style game. The content for the game comes directly from the student's current progress from the course(s) they're currently enrolled in. They'll always have someone to play against too, as Quiz-Off uses an advanced AI, disguised as a human player, when no real players are available.

Joey really enjoys playing games on his phone. But he often gets distracted by them while studying.

Joey uses the Quiz Off feature of our app to study WGU material in a fun game format where he gets to challenge another player.

Joey feels happy that he gets to study and play at the same time.

Incorporate Pitch Ideas

While the main pitch idea to focus on was Quiz-Off, the other eight ideas were not discarded. In fact, four of our other pitch ideas were set to be incorporated as features of our mobile application.

1 Clear View

In the application, a student can choose to bookmark a particular question. These bookmarked questions can then be viewed and organized by the user, or even be sent to a friend of the student. The pitch idea for Clear View began as a way to address problems that occur when a user doesn't understand the underlying concept of a question. After further discussing this idea during the workshop, it served as the basis for our implementation of allowing users to bookmark questions.

2 Idle Reminders

With the Idle Reminders pitch idea, the app detects when the user is idle at home and reminds them to study. This feature ultimately was incorporated into the application in the form of push notifications. These notify the user to utilize the app when they had been absent from it for a specific amount of time. The user can set custom and personalized reminders to help keep them motivated, while also helping to curb procrastination

Hints

Providing question hints to the students are a necessity in creating an effective instructional environment and an engaging user experience. Incorporating this idea into our app means that every question will have an accompanying hint to help guide the student in finding the answer. Additionally, user metrics can also be gathered for each question, monitoring which questions the hint is used for the most, thus signaling an area that needs improvement.

Schedulr

This feature provides a method for the student to access and modify their WGU calendar from within the application. It can be used to assist students in finding time to study within the app and for setting goals to achieve in the coming days, weeks, and months. Ideally, the student will receive email reminders for the events and goals they create, which can also be accessed by their student mentors. This ultimately assists the learner with time management, while also motivating them to stay on task.

PRODUCT SPECIFICATIONS AND GOALS

Minimum Viable Product

Given an extended period of time, the app could support a multitude of features to enhance the learner's experience, but we only had a single summer to fully spec out and implement everything. Because of this, we established a minimal viable product (MVP)[3] to better focus our efforts. This resulted in some features being the target of our implementation efforts and others being fully scoped out with accompanying high fidelity screen mockups.

MVP Implementation

The core of our implementation efforts were focused around implementing the app's practice mode. This is because it's the core functionality and feature of the fully scoped app, allowing students to answer formative questions both on and offline. Our remaining implementation efforts were put forth toward creating the application program interface (API) endpoints needed for the app.

MVP Scope and Mockups

While the base pitch idea Quiz-Off is most similar to the app's challenge mode, we did not implement that mode. Scoping out the specifications of this mode along with detailed screen mockups was an essential non-implementation MVP item. Additionally, the remaining features of the app that we had previously discussed were to be scoped out in a manner that details how they could be implemented. We've included in our final deliverable how these features would integrate with the system as a whole. Ultimately these specifications and screen prototypes can help guide the development team into implementing these features in the future.

9 Pitch Ideas from Spring

Pitch Name	Description	Included
Quiz-Off	Trivia-style question game	✔
Clear View	Ability to bookmark and review questions	✔
Hints	Providing guiding text for questions	✔
Idle Reminders	Using push notifications to prompt the user to study	✔
Schedulr	Utilizing a calendar for time-management and goal setting	✔
Skynet	Taking over the user's phone and prompting them to study	✘
Self-Explanation	Prompting the user to explain their reasoning	✘
Flashcards	Mobile flashcards generated from course materials	✘
Multi-Sensory	The use of vibration and haptic feedback for questions	✘

Green: Main set of pitch ideas implemented for the project
Yellow: Placeholder implementation with scope and high fidelity mockups
Red: The ideas were discussed, but not included in the project's scope

Practice Mode

The practice mode is the core functionality of the application. This mode allows the student to select any number of modules from their courses, both current and previously enrolled. A set of formative questions are then pooled from those selected modules, with the user selecting how many questions to answer per practice mode session. Our logic used to select these questions for the given modules does so in a way that prioritizes the user's weaker skills. While answering the questions, the users are able to ask for a hint or bookmark a question for later viewing. Upon answering a question, they're presented with tailored feedback for the question based on their selected answer. Additionally, the user is able to navigate to previously answered questions for their given practice session. They're even able to mark a question so that it'll never be asked during practice mode again.

Challenge Mode

At its core, this mode is similar to the aforementioned practice mode. However, in this mode the student isn't just answering questions, but they're competing against another "player". This mode allows the student to challenge a friend with the app or play against a random person. It matches players based on their sharing of a particular set of common courses that they're currently or previously enrolled in. If no such player can be found, then they'll play against an AI that's representative of an actual player. Each player then receives a set of questions pooled from their active courses and targeted toward skills that both players are weaker toward. Players are scored based on both how quickly they answered the question and the accuracy of their answer. Additionally, feedback for the questions is delivered after the challenge is over, as to not cause time delays or pressure on either player causing them to skip the beneficial feedback.

Additional Features

In addition to the MVP and the two primary game modes, a set of additional features were to be both implemented and scoped out. These mostly came from the four pitch ideas that turned into features of the app. A few of these features also resulted from our twice-a-week meetings with WGU.

Two features from our initial pitch ideas that resulted as fully implemented features were the ones that represented hints for questions and the ability to bookmark a question.

A few of the features are implemented as placeholders within the app and accompanied with specifications on how to go about implementing and integrating them within the app. In particular, the schedule and friends pages have accessible screens in our final implementation, but they can't be interacted with outside of navigating to them. The schedule page, resulting from the pitch for Schedulr, provides the user with a calendar to set goals and assist with time management. The friends page is a screen where the app's user can view their added friends, who also use the app, and message or challenge them to a game.

The reminder functionality is a feature which displays push notifications to the user prompting them to make use of the app and stems from the Idle Reminders pitch. It's one such additional feature that we solely scoped out and did not implement due to framework constraints. Another feature that was scoped out is the concepts of badges within the app. If implemented, users would receive certain badges for making progress in their various courses and modules with respect to both accuracy and quantity of questions answered.

DESIGN PROCESS

User Flow

To begin our design stage, we wanted to identify the core functionality that our app should offer the user. We explicitly talked through the purpose of the app, asking important questions along the way:

- **Why would users use the app?**
- **What do users expect to gain?**
- **How will users be learning within the context of the app?**
- **How can we maximize this experience?**

This was an essential step, as listing the functionality served as a way to identify which interfaces would be needed. We were also able to see how the different core functionalities of the app could interact and be combined with one another. This was a key component of our design process, maintaining the app's purpose in all of our design considerations.

Following this, we identified common features found across a variety of iOS and Android applications that were of a similar trivia-style, such as QuizUp[4] and Trivia Crack[5]. A user's experience in the app is key in getting them to both use and learn from it. Users expect a certain level of consistency, both from mobile applications in general and ones intended for a specific purpose. To the user, our app is an educational one that asks them a series of questions. Thus, our app should behave in a similar manner, to some degree, to other applications that fit this typing. By identifying common app features, we were able to identify commonalities that we should include in our application to provide the user with a consistent and expected set of interactions.

We then combined the features that enacted the app's purpose with commonplace app functionalities to create a base specification of user interactions. These user interactions ranged from basic functionality, such as navigating via a menu to app specific functionality, such as challenging a friend in "challenge mode". Once we established a map of user interactions, we created a set of low fidelity screens that mapped these interactions to a specific control in the app.

These screens helped us to generate a tentative user flow, allowing us to see which screens would be accessed when performing the various tasks. Mapping out a path of user interactions enabled us to identify any potential pain points or areas that could be made more efficient for the user. It was also beneficial in helping us create new screens to meet the different interaction needs that we hadn't originally anticipated.

Feature Competitive Analysis

We looked at several existing mobile applications such as Khan Academy[6], Coursera[7], Duolingo[8], Google Primer[9], trivia applications, and social media applications to inform our design decisions. We were particularly interested in the following design aspects: navigation, screen layout, home screen contents, user profile contents, and the design for a question screen.

Navigation Layout

We had long discussions on which popular navigation option to adopt, debating between hamburger style menu or a tab view one. A hamburger style icon is comprised of three stacked horizontal lines and opens up a menu from the left side of the screen, like navigation in the Gmail[10] app. On the other hand, a tab view menu provides the same navigation options via a footer that's always displayed on each page, like Instagram[11]. Since our target audience includes both iOS and android users, we were a little conflicted about the placement of a navigation bar. We looked at several iOS applications for the tab view menu and google applications for their hamburger style menu option. We also read several design blogs to help inform our decision, such as lovelyui[12] and InspiredUI[13]. Based on our research if there are more than five important screens, a hamburger style menu option is preferred.

Home Screen

We have two important modes in our application, practice mode and challenge mode. We weren't exactly sure how to display two very important aspects of our application and make them easily accessible to our users at all times.

We looked at several applications that tried to layout a page with dual functionality. A tabbed view mode emerged as the most popular way of designing a screen with more than one functionality.

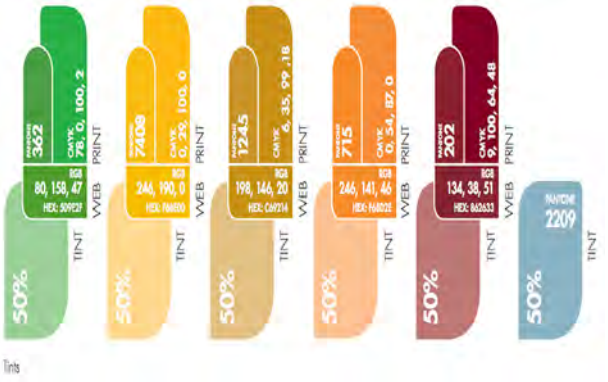
3 User Profile

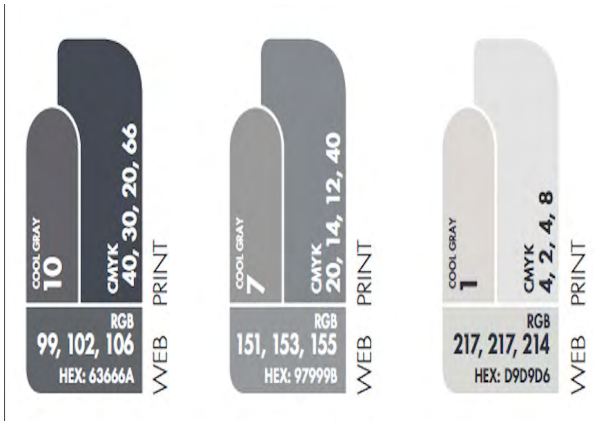
We looked at several learning applications, trivia applications, and social media applications to see the kind of information they present to their users on the profile screen. Several of these applications combined settings options, changing display name and display picture options all on the profile screen. We really liked the idea of having a single screen for our users to access and edit their profile information and thus incorporated it in our app design.

4 Question Screen Design

Designing the questions screen was the toughest challenge for us, especially because most of the questions for the Acrobatiq courses are text heavy. We looked at learning apps such as Duolingo[8], Primer[9] in particular for their design of multiple choice questions, placement of hint button and feedback screen layout. We also wanted to see if these applications provided the users an option to go back to the previous questions answered within a session. Some trivia applications[4,5] provided this option with an explicit back button and some provided it with a swipe gesture. We incorporated both options for our app design since we will have a wide range of users from different age groups which will prefer either of the options.

WGU Style Guidelines





PRIMARY TYPEFACE — FUTURA STANDARD

AaBbCcDdEeFfGg
0123456789

Futura Standard Light

AaBbCcDdEeFfGg
0123456789

Futura Standard Medium

AaBbCcDdEeFfGg
0123456789

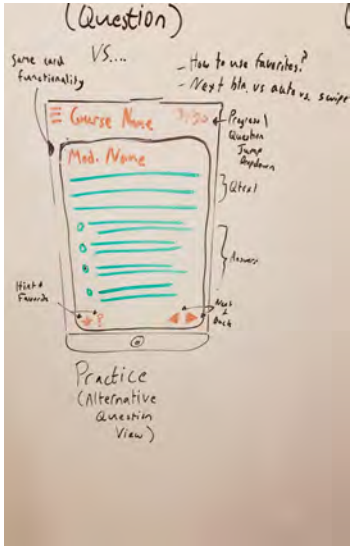
Futura Standard Heavy

Style Guidelines

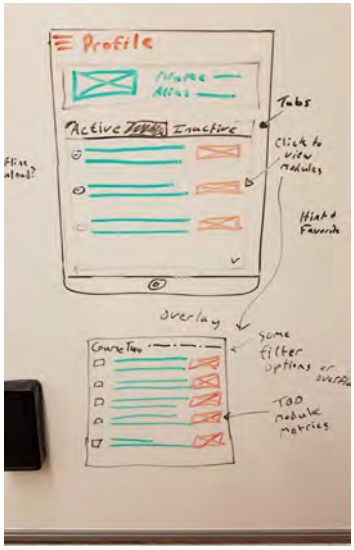
The aesthetics of the app play a crucial role in the overall user experience and can even promote or hinder learning within the app. Before deciding the layout of the screens, we set out to develop a set of style guidelines to help dictate the color and font choices used about the app. To help develop our set of style guidelines, we created a moodboard[14]. The moodboard helped us to see how the varying colors and their proportions invoked different feelings, such as dreary when we used excessive amounts of grey and blue or exciting when we added sections of bright colors. We wanted the color and font choices to convey a lighthearted and fun feel to the user. Although they're technically studying, we wanted to disguise it in a way that was more of an engaging and entertaining game. Also, with the app being on a mobile context, we wanted to use matching fonts and colors that were appropriate for our limited screen sizing.

Shortly after creating our moodboard, we discovered existing WGU style guidelines, which also contained a color palette to follow and a particular set of fonts to utilize. It was exciting to see the majority of our guidelines matched those of WGU. For instance, we wanted the primary colors of the app to be WGU blue and WGU light blue to convey brand stewardship. Even our selected primary font, Century Gothic, was a close match to the WGU's suggestion of Futura. It was a smooth transition to update our style guidelines to match those as set by WGU. Even the marketing logo had a particular set of guidelines for us to follow, detailing appropriate use of the WGU letters and owl logo. Ultimately both sets of guidelines used in both our screen mockups and final implementation of the app, which can be viewed on the previous page.

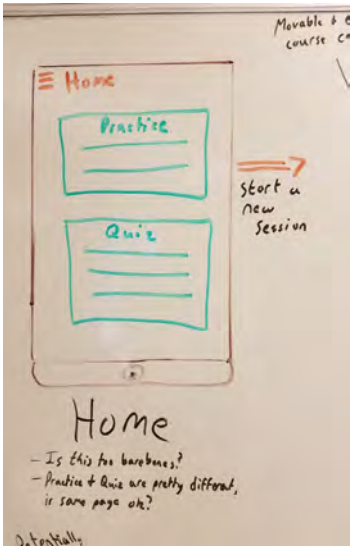
SCREEN MOCKUPS - LOW FIDELITY



One of two initial question screen variants



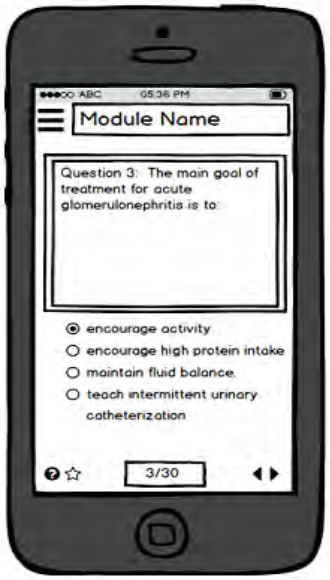
Profile screen with an overlay



Base home screen design with questions below

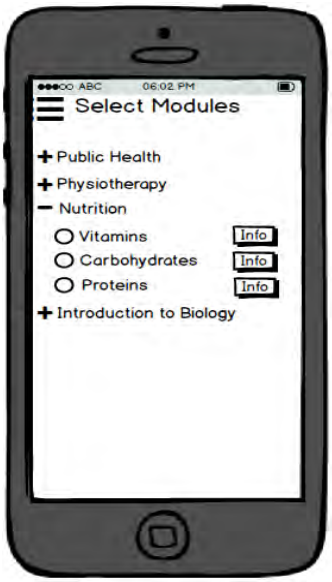
Low fidelity mockups often consist of sketches, like the ones here, and are great for high-level brainstorming and collaboration. They're void of meaningful color and even text, outside of a few keywords to denote events and page titles. These were the first set of screen mockups we created, which we used to establish a user flow. Prior to creating these, we mapped out user interactions that correspond with the app's purpose and constitute an expected mobile experience. Creating these mockups allowed us to quickly determine what pages we'd need to incorporate all the actions the app offers. It also provided us a way with establishing questions for each of our initial screens that were then asked during our phase one user testing.

SCREEN MOCKUPS - MEDIUM FIDELITY



Question screen with hint, favorite, next and back

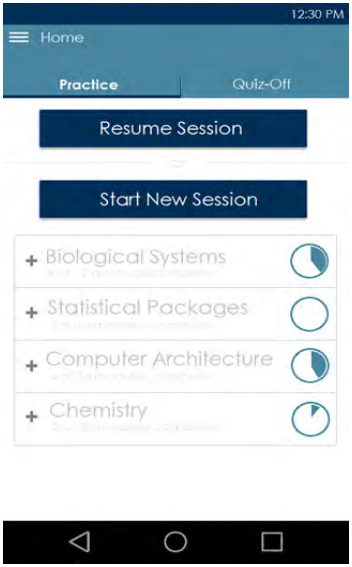
Home screen with all the options for Practice and Quiz modes



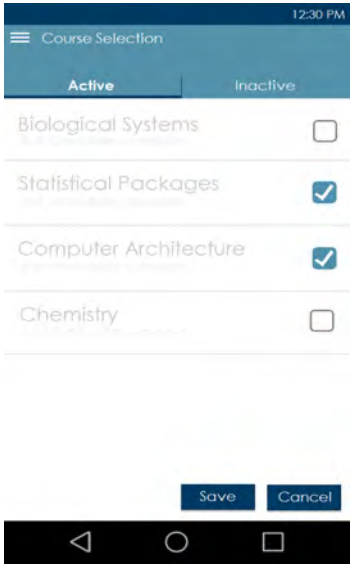
Screen design for when module selection was its own page

Medium fidelity mockups are often digitally structured version of sketches that are meant to be semi functional, but not including any design aesthetics or graphics. These were the second set of screen mockups we created, based upon our rapid iteration to the low fidelity ones. They were informed by our heuristic evaluation conducted at the start of phase one user testing. Additionally, our second round of competitive analysis, targeted at existing trivia-style applications, guided us toward certain layout decisions like the collapsible lists. We used these mockups to gauge the intuitiveness of the app's controls and solidify navigation about the app. These mockups were used for the bulk of our phase one user testing, as participants interacted with our screens.

SCREEN MOCKUPS - HIGH FIDELITY



Our home screen prior to the changes from phase four



The course selection page when it's being edited

One variant of the question screen tested for phase three

High fidelity screen mockups are ones that most closely resemble the final design state of the prototype. When we designed this set of mockups, most of the necessary design assets and components were developed and integrated in our code base. We used these mockups to apply the WGU style guidelines, which conveyed the look and feel of the app.

These mockups were used in our phase three user testing, were we created several variants of each screen with a high level of detail and had users select based on their preference. Following phase three testing, we implemented the participant feedback to redesign several screens of this fidelity.

USER RESEARCH

User Testing

Usability studies for mobile applications typically involve one of the following research questions (Zhang & Adipat, 2005)[15]

- **"Can the proposed presentation methods help the users easily search for information?"**
  Such questions focus on exploring and evaluating different approaches to effective content presentation.

- **"What are appropriate menu, design and link structures?"**
  This question focuses on how to design menus and link structures to make them user friendly.

- **"Can users easily carry out specific activities?"**
  This question focuses on how easily can users perform the intended activities on a mobile device.

- **"What are the types of data entry methods that will be helpful for the users?"**
  This question focuses on ways in which users can enter data to the mobile device example: keyboard, stylus etc.

- **"How well can the app be used in the mobile context?"**
  This question focuses on how well the mobile app can be used in the context of its use like while travelling versus sitting on a chair versus in public spaces etc.

While every question has some relevance to all the apps, and the above list primarily focuses on the instrumental and non-aesthetic aspect of the experience, it helped us design our studies for testing basic functionality.

We chose to focus more on the navigation related usability testing and whether subjects could perform specific tasks. We did four rounds of user testing. Our minimum target number of participants was five subjects for phase two, three, and four as most scholars agree that 80% of the issues are revealed by testing with five subjects[16].

Phase 1 : Heuristic Evaluation

The first was a heuristic evaluation of our low fidelity mockup. The purpose of this test was to identify any obvious improvements based on the evaluation of an expert in HCI.

Phase 2 : Tree Testing

The second testing was tree testing on the medium fidelity mockup revised after the heuristic evaluation, which intended to measure the basic navigation and link structure of screens.

Phase 3 : User Preferences

The third phase was a medium fidelity prototype, which incorporated the findings from phase two and added colors and some design features that could be tested remotely. The third phase helped us finalize on design decisions related to visual presentation, color, and layout .

Phase 4 : Implementation Testing

The final fourth phase was a high fidelity mockup in which we tested the intuitiveness and usability of our actual implemented app .

PHASE 1 : HEURISTIC EVALUATION

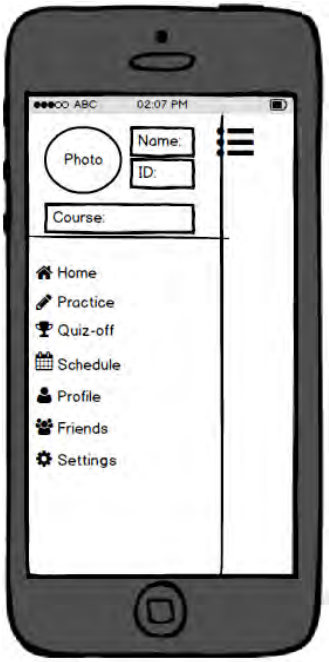
Heuristic evaluation is a research method where the usability of a software is evaluated by presenting it to an expert trained in usability. The expert uses the "heuristics" prevalent in the industry to evaluate the product. We recruited one HCI graduate student for the study to evaluate our first low fidelity mockup.

From our first mock-up there were quite a few things that needed improvement. We made seven changes to our design based on the feedback got from the heuristic evaluation. One of the suggestions was to add verbs where we wanted the users to perform specific actions. We changed "Modules" to "Select Modules". We added an explicit "Edit" prompt to the active/inactive courses which was lacking in our initial mockup, which is where the users were expected to add/drop a course for practice. We also added "Save" and "Cancel" button after the "Edit" button to prompt the user to confirm the changes. The "Quit" button was hidden in the menu and we the lack of quit could have caused anxiety so we decided to make it explicit on the top of the screen by adding a "x" symbol. Ultimately the bulk of these changes revolved around making the text more actionable to indicate certain elements could be interacted with.

PHASE 2: TREE TESTING

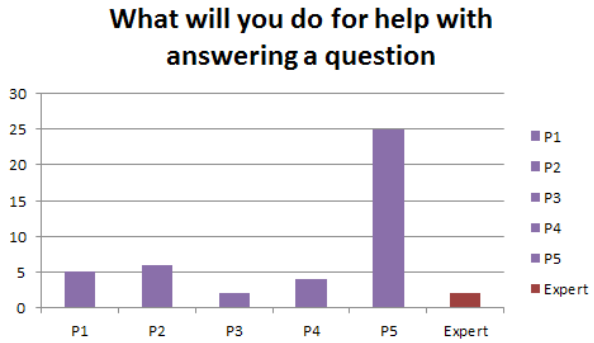
Tree testing is a usability technique used to measure the findability of topics in a website or app. We recruited five students from the CMU campus to do the first user test. The test included some pre-defined tasks for the user and the users were measured on factors, such as whether or not they were able to complete the tasks and how much time they took. The test was done on an android device running our prototyping software that displayed the medium fidelity mockups.

The medium fidelity screen mockups were used to test app navigation, memorability of features and link structure of the design. The absence of aesthetics at this phase was necessary as it helped avoid distraction to any feature that is non-instrumental and get usability data purely based on the link structure and verbal display of the features[17]. We used Balsamiq to make the medium fidelity mockups and then used those mockups to upload them on InVision. We did this because Balsamiq doesn't generate a url that can be accessed via a mobile device. InVision generated the mockups in the size of the android device we were using. This helped us test the medium fidelity prototype on a mobile device, thus replicating a more realistic user experience for the app.

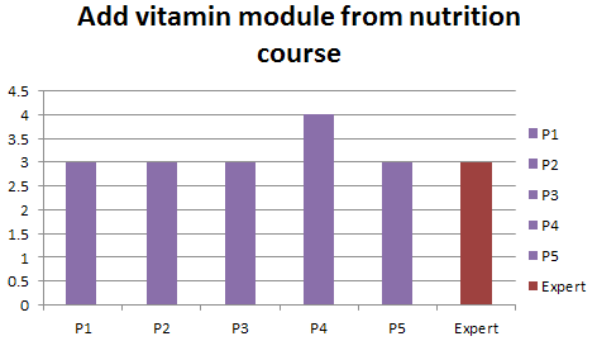


Findings

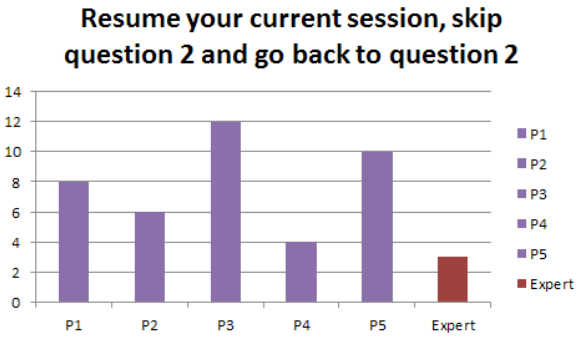
This graph represents the time taken for a task by the five participants compared to the expert. In this case the expert was the designer of the prototype. The task description asked the participant to find the hint button. Most participants found it intuitive and did it in a time that was close to that of the expert. However, as we can see in the figure, the participant P5 took disproportionately high time to find the hint button. The real insight here, however, has nothing to do with the hint button. The subject P5 was unable to navigate back to the question screen and it took her some time to find out where to go for the question screen. This was a clear indicator that the navigation mechanism we had in place was not intuitive.



The graph below shows that this particular task, although longer, was accomplished by everyone at roughly the same time. This implies that it was a fairly intuitive task, as all the participants were able to complete the navigation in a timely manner.

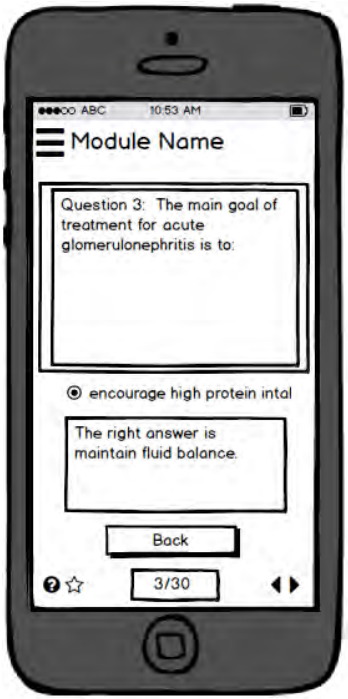


There is much more variability in this graph compared to the others. The task for this graph was to resume a session, skip a question, and then go back to that question. The reason for the variability was that some students pressed quit instead of skip, which led to the increase in time. Subsequent changes were made to the design and both quit and skip were removed from the interface.



Actionable Changes

- The purpose of the feedback screen was not clear to the users. The possible reason was that the content we used in the feedback screen was not descriptive enough. Another potential point of confusion was whether the feedback screen was giving feedback or providing the answer to the question.



- Adding a course was not clear to some participants. This was an important finding because the course changing option was on the profile page, while there was an option to add modules from within a course on the home page. Students got confused between the two and we eventually decided to remove the settings tab from the menu and incorporate its functionalities elsewhere in the app.

Related to the previous finding was the fact that the students were confused about the concept of a module and couldn't differentiate it from courses. This finding, although important, wasn't considered an immediate concern because our subjects were not real WGU students and hence were not familiar with the terminology that actual WGU students might be very well familiar with.

The last major finding was about the distinction between active and inactive courses. The distinction was not clear to the students. This could have been because it was in the profile screen or because of the term active and inactive itself. This caused us to struggle with finding the correct words to use in order to denote these current and previous courses that questions can be pooled from.

- Other findings include a rethinking of the layout of some of the screens, such as the home, question, and profile screen. These results led us to improve the layout of our designs as we referred to existing mobile applications for inspiration. For phase three of the user testing we added a few new elements since it was a medium fidelity prototype and hence involved colors too.

Unclear Tasks Identified	Actionable Solutions
How to add a course?	Added a “My Courses” tab in the menu
How can notifications be disabled?	Removed the “Settings” tab in the menu and added it to the “Profile” screen
What are active and inactive courses?	Move the section to the newly created “My courses” tab and remove it from the menu.
What are modules ?	Low priority finding hence ignored for the time being.

PHASE 3: USER PREFERENCES

The phase three user testing was done remotely via the web. The platform we used is called Notable. It consisted of primarily two kinds of tests, preference tests and annotate tests. Preference tests are tests where two or more variations of a given design element are presented to the user and participants have to select which variation they prefer. In the annotate test, the subjects can select a section of the mock-up presented on the screen and enter an open response for that portion of the screen. This open response may include aspects that they like/dislike or are confused about.

The phase two user testing informed our designs used during this phase, but we didn't validate those changes in the interest of time. Additionally, those kinds of measurements required are different from ones that can be taken remotely. The key questions that we were trying to answer in phase three testing were related to user preferences of certain implementations of our ideas. As is often the case in design, the final choice for a color scheme or a type of symbols used to communicate something is often made based on empirical evidence on user preferences. Thus, the remote testing for phase three was primarily aimed at measuring user preferences for different display ideas. In order to collect more qualitative user feedback we also presented them with annotation tests as mentioned before.

Since we were testing remotely, we used actual WGU students for data collection, as their feedback is invaluable as our prospective users. We collected full responses from ten students and partial responses from four more. Partial responses typically include data on the some of the preference tests until the users stopped responding.

Student Annotations

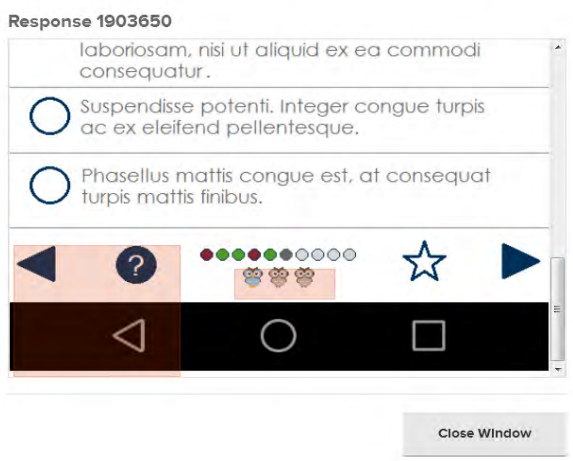
"This is a great tool to help with pacing"

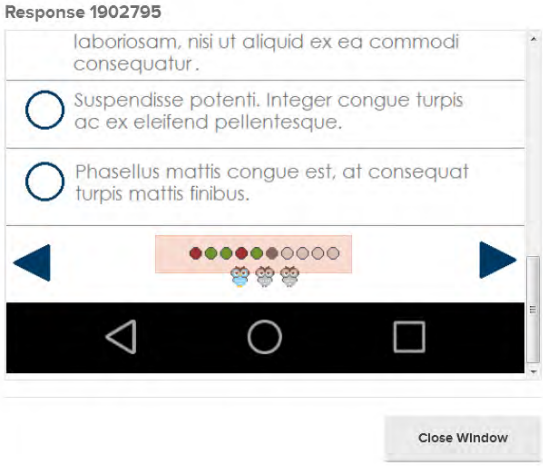
The subject found this display motivating and the display of numbers to communicate progression was greatly preferred by students.

"Not sure what this is, but looks cute."

"What are owls for?"

The display of owls was likable by participants, but their purpose remained unclear to the majority of them. While some subjects reported the owls to be visually appealing, that didn't necessarily mean the purpose of the owls was clear.





"I don't understand the owls. Is there something specific about their coloration?"

"Does the OS back button behave the same as the app specific button above it?"

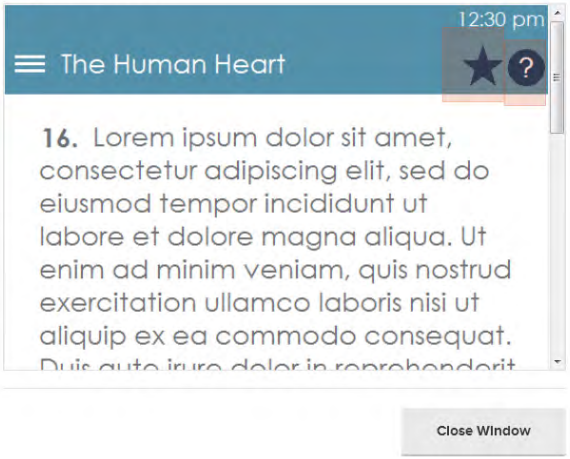
Some subjects couldn't understand what the owls were meant to communicate, which was progression throughout the session of questions. One subject got confused with the functionality of the back button because of its visual similarity to the OS back button.

"I am assuming it is a timer or a progress mark? It isn't very clear from this screenshot."

"I like the instant view of right/wrong answers"

Some subjects were able to understand that the color represented by the dots was conveying whether their attempt was correct or not. At the same time some others saw it only as communicating progress.

Response 1903651

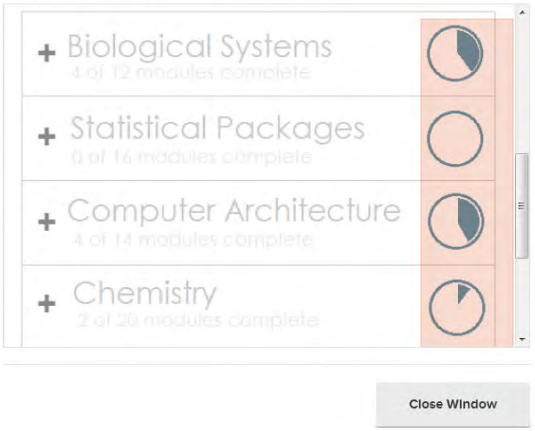


" I like the help up above, where I am less likely to accidently press it. "

"I preferred the star option below, as I assume it is associated with the display question not the overall navigation."

Some people preferred the hint button above while others didn't. Eventually the responses evened out at 50%. The bookmark button at the top was confusing to some students.

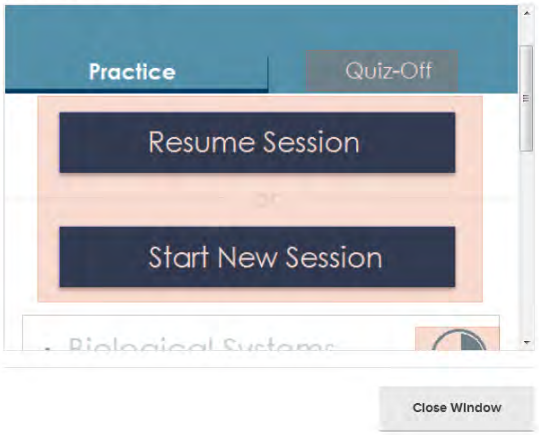
Response 1903637



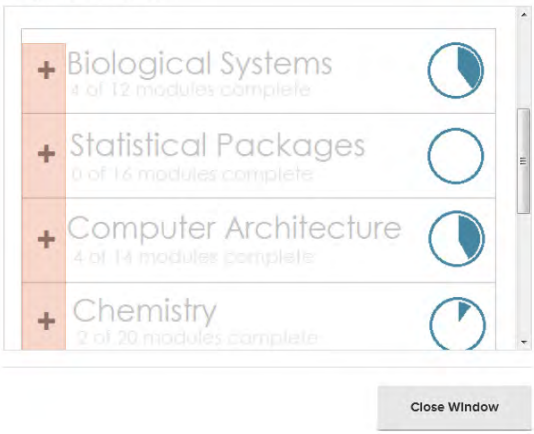
"This feature shows the progress of a unit."

The progress of a unit was quite clear to most participants. 10 students and partial prospective users. We partial prospective partial.

Response 1902802



Response 1903652



"This is great! It's so hard to resume on the current app."

It was good to see students understanding the various buttons on the screens without them needing to be explained. However,being compared to the existing WGU app means students might have existing notions about certain functionality within our app, which could be beneficial or harmful to the user experience we're creating.

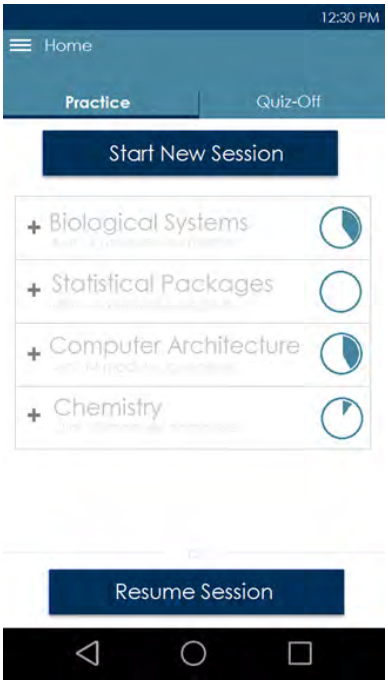
"Does the plus expand the entry or add to a queue? Since, the color is the same as the title, it adds a little bit of confusion."

Our usage of the color gray confused some of our users. They interpreted the gray as an indication that something was disabled, when that was not the case.

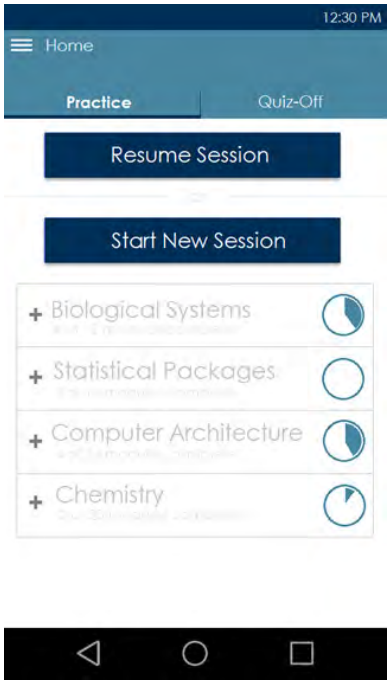
Preference Testing

The results for part A indicate that users prefer to have the page's main functionality, starting a new session and selecting courses, at the top most part of the screen. Results for part B indicate users prefer a combination of numbers and icons as a representation of their progression.

A. Testing Layout Preferences

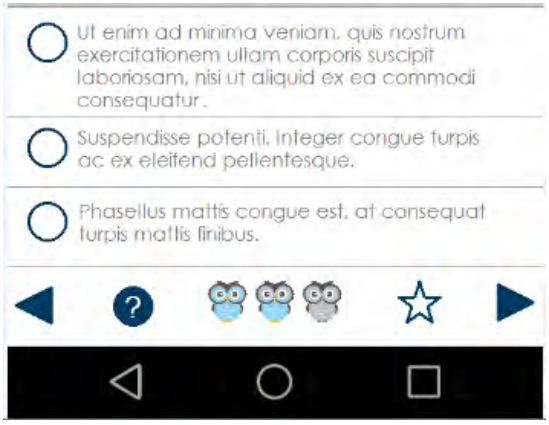


Variation A: **8/11 votes**

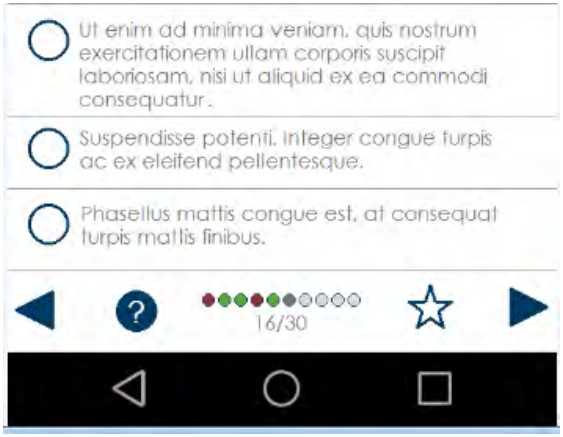


Variation B: **4/11 votes**

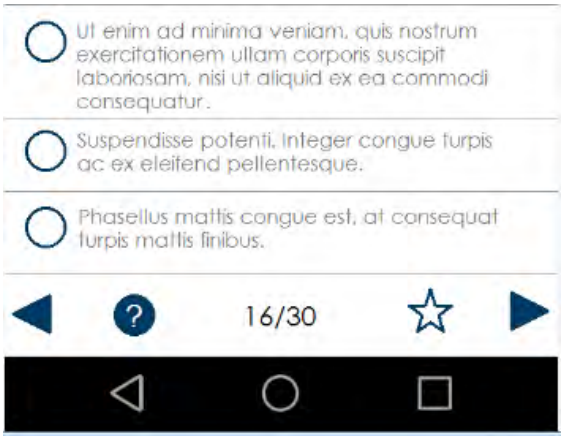
B. Testing Progression Representation Preferences



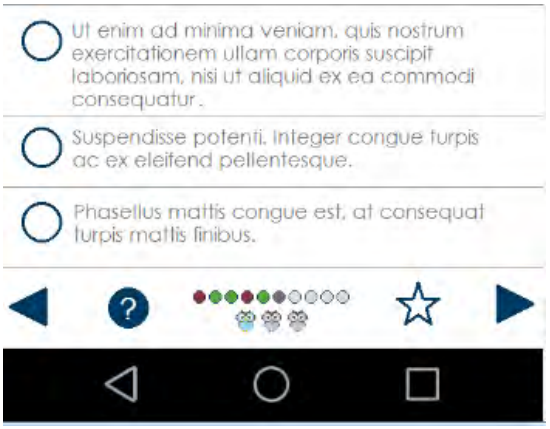
Variation A: **9/30 votes**



Variation B: **25/34 votes**



Variation C: **17/30 votes**



Variation D: **13/34 votes**

Actionable Changes

Phase three testing gave us empirical basis to narrow down on ideas for which we were debating between two options. It helped us finalize our design for the layout of our home screen, display of progression, placement of icons about the screen, like the hint and favorite icon, and to get feedback on any potential sources of confusion across all the screens. We tested the following:

- Whether users prefer owls versus numeric or visual presentation when it comes to representing their question progression for a session. We found that our participants prefer numeric presentation.

- The placement of our hint button was tested and the results indicate equal preference for both mockups.

- Different color variations for our app were also tested and we went on to implement the one that got maximum votes.

- The layout for our home screen and got a high number of votes for a particular layout style that we ended up implementing.

All these questions required empirical evidence because there is no way to know what is intuitive and appealing until we try to use it. Phrase three results helped us finalize on many such small design ambiguities we had discussed as a group, which were often ones we could find in existing apps or that were supported by the literature. For instance, when we didn't know the best layout for our home screen, we looked to other mobile applications or research regarding button placement for a primary screen. While they helped to generate ideas, we had no conclusive evidence to go off of until we conducted this phase of user testing.

PHASE 4: IMPLEMENTATION TESTING

Phase four testing was done using our implemented high fidelity prototype. We wanted to get any final user feedback that we could offer as future suggestions to WGU. This phase's tasks were performed using our implemented code base. It was a good opportunity to test the code outside of the programmers that developed it. The participants we recruited were two WGU middle-aged students and three CMU graduate students.

The feedback from phase four user testing yielded interesting, yet thankfully minor, changes. Both WGU participants took longer than expected to locate the navigation menu, while CMU students did not. This may be due to the fact that the relatively younger CMU students might be more tech savvy than a more diverse age group of WGU students.

We had to provide scaffolding to one WGU student to get them to utilize the hamburger menu for the first task, which was "How would you go about adding a new course?". She first clicked the "Start New Session" button thinking it would prompt her to add a course. After scaffolding her, she went to "My Courses" and identified inactive as courses previously done. This was partially correct, but she couldn't infer that inactive courses can be added to make them active. An additional source of confusion came from the placement and size of the "Edit" button because the subject's thumb was covering the button. The CMU students were fairly comfortable while navigating about the app, which we attribute to their higher use time of mobile applications. One WGU student and one CMU student reported that they didn't understand the point of the scheduling tab.

Another WGU student was appreciative of the fact that she could decide the number of questions to be presented with for each practice session.

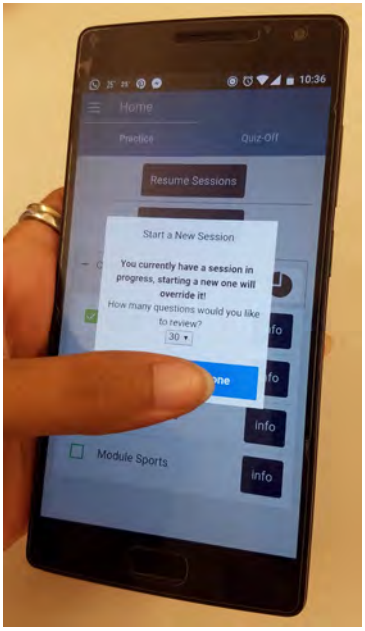
"I like the fact that I can select the number of questions. I will probably never do more than 30 questions. Because 30 is a lot."

One of the WGU subjects mentioned that she would prefer a choice on when she wants to see feedback.

"Some WGU tests give a choice when would you like to see the feedback - after every question or at the end of the session. That choice is good."

Some students expected the navigation back to the home screen to always be visible, instead of clicking the navigation menu to view it.

"A lot of time the home icon is at the top or bottom somewhere and is always visible."

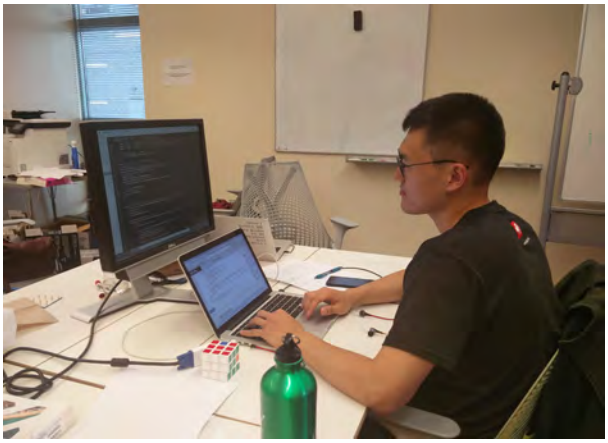


IMPLEMENTATION

Acrobatiq

Going into the summer, integration with Acrobatiq's services was one of the larger challenges we took on. The challenges lay in gathering buy-in from a partner organization and learning another team's code base. While the latter of the two challenges might seem the heftier of the two, we stressed the importance of the former. We imagined the partner organization would have set regulations and bureaucracy that would slow our progress. However, Peter Bertuglia, an Engineer Manager at Acrobatiq, was extremely helpful and available when we encountered technical blocks in our development iterations.

These Acrobatiq services we developed, on top of their existing code base, enabled us to access access the various sets of data we need for the app. We were able to gather the courses a student was enrolled in, both current and previous ones. From this point we were able to gather every module for the given courses and then pool all the formative questions for each module. This gave us all the questions relevant to a particular student, which we could then run our question selection logic on.



Our integration involved building three APIs (see Appendix A for technical specifics):

1 Authentication

We needed a mechanism to safely access Acrobatiq's services, where we could gather our needed data for the student. This data is essential for the application's core functionality .

2 Getting present & past courses

Since a student may want to study content from past courses (as content across courses builds on one another), we wanted to get all courses that a student has been enrolled in.

3 Getting all formative questions

A mobile use case is geared toward formative assessment, as opposed to summative assessments which Acrobatiq has.

Framework

One of the most important technical decisions we made was choosing which programming languages and frameworks we were going to use for development, especially given that none of us have had experience building native apps. Instead, we had a team of system and web developers charged with developing a minimal-viable-product in a limited timeframe. With those constraints, we chose a popular "hybrid" framework called Ionic. The following applications are made in Ionic:

Ionic is hybrid in the sense that it uses web technologies (HTML, CSS, Javascript, AngularJS), to build mobile applications. For us, with our timeframe and relatively simple requirements, we viewed the framework as the obvious choice. We weren't building an highly complex mobile application that deeply integrated with a phone's operating system. Uber would be difficult to build using Ionic. Our app and our development speed were greatly aided by this hybrid framework. Some further validation that gave us confidence in Ionic was its strength in documentation, Github community, and quality of apps already built using Ionic.

Database Design

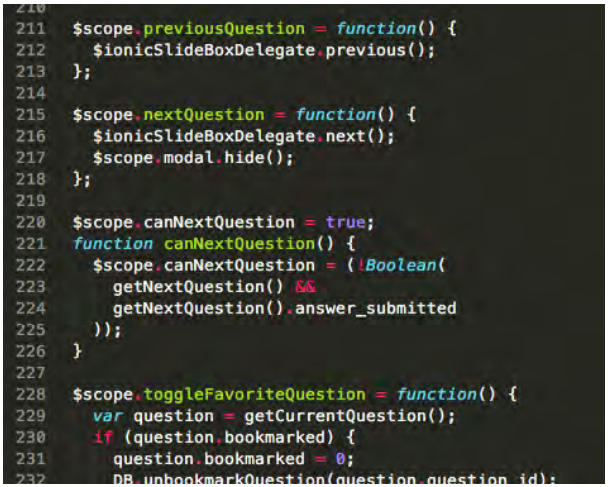
One of our main goals for this application was to provide offline access to the students. This meant that we had to store questions and responses on the phone to remove a large dependence on a server. Much time was devoted to analyze the kind of data we would get from Acrobatiq via API calls for each question and also the kind of data we would require in order to evaluate skill accuracy and to inform our question selection logic. One of the driving concerns we had was on the memory footprint our app would have. Given the multi-media format that many questions on the Acrobatiq platform had, storing all the question data on each mobile device could balloon up to large numbers. However, it's natural that for a learning on the go app, text based questions were most fit (limited screen real estate, don't require quiet/headphones). Thus, a large memory footprint was not an issue for storing question data on each mobile device.

For our current implementation, we're using two storage options:

- **LocalStorage**, used for storing login credentials (e.g. cookies)
- **SQLite**, the traditional database: Used to store question / answers to enable offline access

SQLite

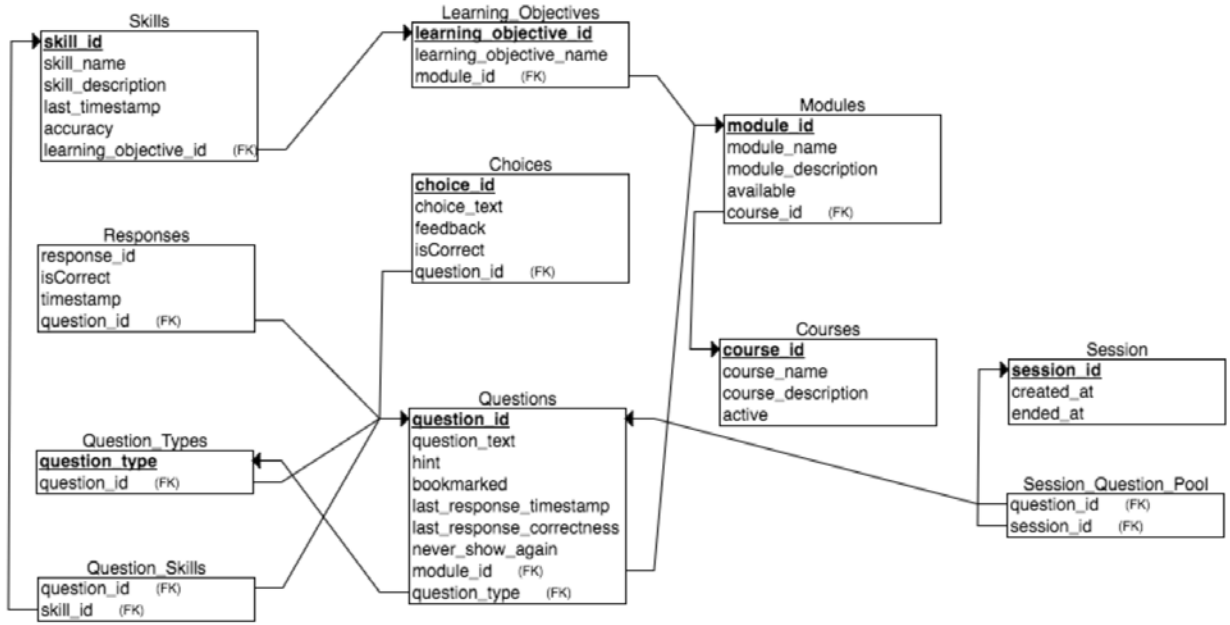
We preferred a structured query language (SQL) when working with our data. This is an alternative to caching the data on the phone, which could cause data loss due to the phone only storing it for a limited amount of time. Making use of the Cordova SQLite plugin, we used SQLite data source for managing the data in Android and iOS. We paired this with ngCordova to better compliment our Ionic Framework development with an AngularJS experience.The plugin documentation is very thorough and worth a read. One of the things that we had to keep in mind is that SQLite supports a very limited set of data types. This put some constraints on us when we were designing our tables. For eg: SQLite doesn't support boolean values. We had to use Integers for this purpose.



```
211  $scope.previousQuestion = function() {
212    $ionicSlideBoxDelegate.previous();
213  };
214
215  $scope.nextQuestion = function() {
216    $ionicSlideBoxDelegate.next();
217    $scope.modal.hide();
218  };
219
220  $scope.canNextQuestion = true;
221  function canNextQuestion() {
222    $scope.canNextQuestion = (!Boolean(
223      getNextQuestion() &&
224      getNextQuestion().answer_submitted
225    ));
226  }
227
228  $scope.toggleFavoriteQuestion = function() {
229    var question = getCurrentQuestion();
230    if (question.bookmarked) {
231      question.bookmarked = 0;
232      DB.unbookmarkQuestion(question.question_id);
```

Entity Relationship Diagram

An Entity Relationship Diagram shows entities (tables) in a database and relationships between tables within that database. We had several iterations for the database tables design. In the end we came up with 11 tables described below.



Database Tables

Courses

This table stores all information related to an Acrobatiq course. The four main attributes of this table are : course id (primary key), course name, course description and the active/inactive status of that course within our application.

Modules

This table stores all information related to all modules within a course. The five main attributes of this table are: module id (primary key), module name, module description, course id (foreign key) and the availability status of a module. For future iterations, module can be made available as and when students show interaction with the material on the Acrobatiq web interface.

Learning Objectives

This table stores all information related to all learning objectives within a module. Although we haven't used this table for our implementation, we highly recommend using accuracy measurements for learning objectives for question selection logic in the future. The three main attributes of this table are : learning objective id (primary key), learning objective name and the module id (foreign key) the to which the learning objective belongs to.

Question Types

This table stores the question id and the question type for a question. Question Types can vary from : Multiple Choice, Multiple Select, True or False, Input Type Questions and so on. We know that this information is very useful to decide how to design and render the screen.

Skills

This table stores all information related to all the skills within a learning objective. We spent a lot of time discussing the different attributes of this table. There are 6 attributes : skill id (primary key), skill name, skill description, learning objective id (foreign key), accuracy and last_timestamp.

The accuracy field is just an integer that can take up any of the following values: 0, 20, 40, 60, 80, 100. We're using the simplest knowledge tracing algorithm to calculate accuracy for the last 5 questions of a particular skill. For example, if the user got the last 5 "addition" skill questions correct, then addition skill will have 100% accuracy. If he/she got 2 correct and 3 wrong for the last 5 "addition" questions, then the skill accuracy will be at 20%. Thus at any given time the accuracy value will be : 0%, 20%, 40%, 60%, 80%, 100% for a given skill. We use the accuracy value to sort skills and arrange them from lowest to highest accuracy. We then try to pick a certain number of skills for a given number of total questions selected by the user.

The last_timestamp gets updated every time a student answers a question for a particular skill. We use the last_timestamp value to sort skills of same accuracy in such a way that we select skills with the oldest timestamps first. We will explain this selection criteria in more detail in the question selection logic section.

Question Skills

This table stores information related to the correlation between skills and questions. Since a question can have multiple skills, we decided to have a separate table to show this data.

Questions

This table stores all the information related to a question. The main attributes of this table are :

a. question_id (primary key) : unique id for each question

b. question_text : question text

c. hint : question hint

d. bookmarked : field stores whether or not a question was marked as favorite by the user

e. last_response_timestamp : This field is NULL if the question was never seen before or has a specific timestamp when the question was last answered by the user. We use this field when we pick 2 questions for each selected skill_id in the question selection logic. Our aim is to always show unseen questions to the students first and then repeat correct and incorrect questions.

f. last_response_correctness : This field is NULL if question is never seen before, 0 if the last response was incorrect and 1 if last response was correct. We use this field to pick 2 questions for a selected skill_id when there are no more unseen questions left.

g. never_show_again : Since we don't allow the users to skip a question, we thought that a never show this question again option should be given to them if they really feel very competent about a certain question. The value for this field just represents a boolean.

h. module_id (foreign key) : In our current implementation a question belongs to only one module_id.

i. question_type (foreign key) : This field tells us the type of the question: multiple choice, multiple select, so on.

Choices

This table stores all the information related to the choices for each question. The 5 main attributes of this table are : choice id, choice text, feedback for every choice, whether or not a choice isCorrect and the question_id. This structure works well for multiple choice, multiple select, pull down menu and true/false type of questions.

Responses

This table stores information related to the responses given by the user. It stores the response id, question id, timestamp and whether or not the response given by the user was correct.

Session

This table stores information related to a session such as the session id, when the session was created and when a session ended.

Session_Question_Pool

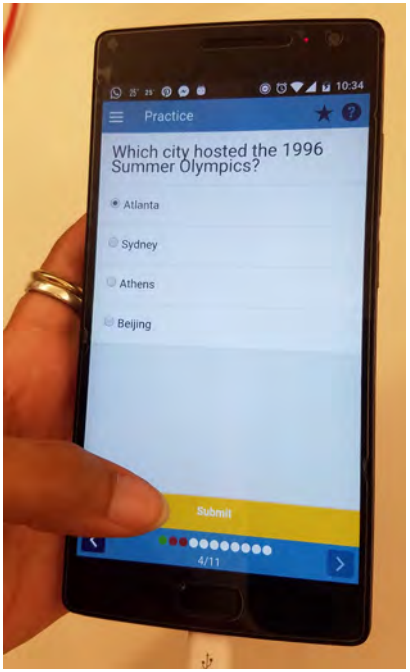
This table stores information related to the question ids selected for a given session id. This table will only store information related to the current session. The session id is used to resume a previous session when the user clicks on the “Resume” option on the home screen.

```
service.insertQuestion = functi

  $cordovaSQLite.execute(db, 'I
          .then(function(result)
              console.log("Quest
          }, function(error) {
              console.error("Que
          })

  }
```

Question Selection Logic

To start a session, the user selects modules from their courses that they want to study and the number of questions for the session. Submitting the selected modules begins a session with questions selected from those modules. We implemented a form of knowledge tracing to go from the selected modules to the session's questions. Specifically, we first found all the associated skills associated with the selected modules. For each skill, we calculated the accuracy for that skill using the past five questions labeled with that skill. Sorting the skills by accuracy from least to greatest, we choose two questions (preferring unseen questions) per skill until we have filled the desired number of questions submitted by the user. This description omit some of the edge cases involved with this process (e.g. we loop back through the skills if one pass was not enough to reach the desired number of questions).

Adaptive learning has been conceptualized in different ways, Acrobatiq provided us with skill mappings that were tied to higher order learning objectives. Our adaptive approach explained above adapts to variability in skill accuracy and also on the basis of recency or potential decay of memory. While there are more complex schemes for knowledge tracing, this form of knowledge tracing is a first example of what's possible with integrated Acrobatiq data. Down the road, future work with Acrobatiq with their own implementation of knowledge tracing should prove fruitful.



FUTURE DIRECTIONS

Conclusion

We began this year with the following hunt statement:

"Explore student personal learning dynamics so that we can build a supporting mobile application in which students can continuously work towards the learning goals of their courses."

After researching and narrowing down our scope from the spring semester, we set out to develop a high fidelity prototype of a mobile application WGU students could use to study. This resulted in an app that quizzes students with questions from the courses they've taken and lets them challenge one another. We conducted multiple phases of user research to refine the aesthetics of our app and incorporate our targeted users in the design process. Further research was conducted on existing mobile apps, design trends, and applied learning sciences to help ensure our app would deliver an optimal learning experience. Concurrent with our iterative design process and research, we programmed a usable version of the mobile application from the ground up. Our implementation efforts were equally informed by our user research, from the interface design, database creation, and even the server code. Ultimately we concluded the project with a working and extensible prototype, complete with detailed specifications and screen mockups for the components we were unable to implement.

Wishlist Features

Of the "nice-to-have" features we set out for ourselves in our product specification and goals(push notifications, schedule, badging, favoriting), we implemented the lowest hanging fruit: favoriting. Of the remaining three, push notifications are definitely the most important. They drive usage as a reminder and a habit builder. A well-designed push notification would be a strong contribution towards user adoption.

Continued Work

Moving forward, we are excited for WGU to put this product through larger scale user testing and development. Our work can readily serve as a strong proof of concept and guide as the project is integrated with other WGU systems. We prioritize the following items for further development.

Onboarding

Onboarding in a mobile context is the process of giving a brief step-by-step tutorial, often highlighting various controls, on how to use a mobile application and the majority of its features[18]. Our user testing found that even when following popular mobile design patterns and implementing student feedback, some features of the app remained unclear to users. For instance, the WGU students we interviewed understood the concept that the app could be used for questions from their currently and previously enrolled courses. However, when interacting with the actual app many individuals questioned the various mechanisms we tested for viewing these courses. Also, what was intuitive to one user wasn't always intuitive for the next. We often would get conflicting feedback on what aspects of the app to change. Implementing onboarding for the app could help clarify these potential pain points and lead to a smoother user experience.

Further Acrobatiq Integration

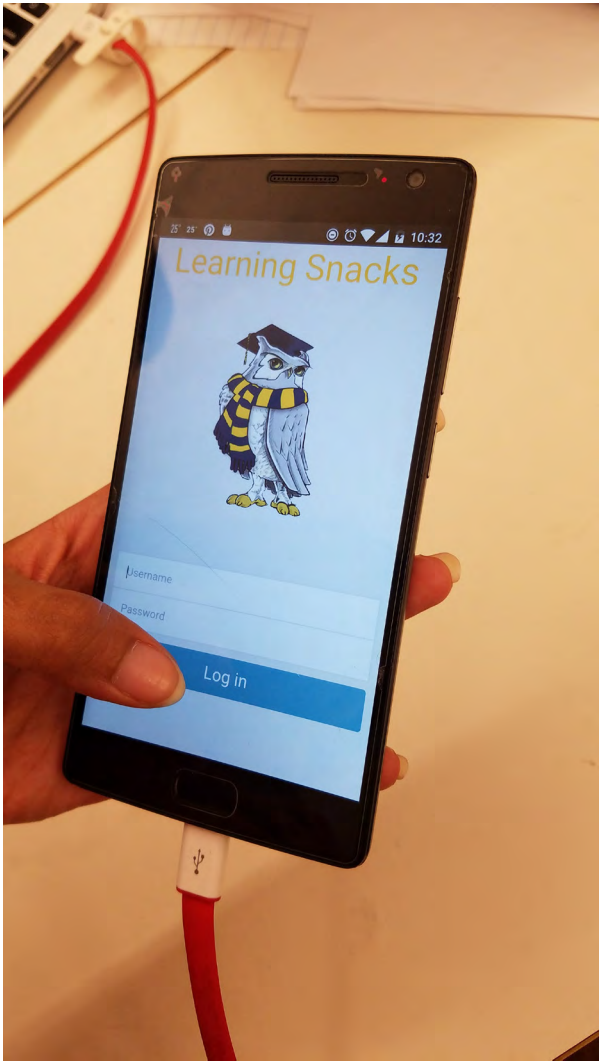
Of the many future directions this project can take, many of them categorically involve working with Acrobatiq. Some are simple: to deploy to a large mobile audience, they need to implement token based authentication (they currently only use session based authentication), as well as only providing the implemented API endpoints to WGU courses. Additionally, while a course and it's questions are communicated to each mobile device, sending response information about a student's responses should be communicated back to the server. But which server? It's likely that response data should at least be sent to Acrobatiq to enable an integrated experience across devices. For example, completing a questions on the desktop should likely be reflected in the logic on their mobile device. However, it seems likely that for interesting data analysts at WGU, having unfettered access to those response and usage logs would be highly valuable. Setting up appropriate access across organizations might be an important point for future work.

Native App

While we enjoyed building in Ionic, a hybrid framework, a native application would prove more scalable for long term development. However, it would of interest to keep an on a Facebook backed project called React Native, which is much in the spirit of hybrid applications but with much more technical depth. While it is still early phases and would likely be an inappropriate choice now, there is an increasing amount of community support and awareness of the project.

Challenge Mode

While we knew that a working version of Quiz-Off was an extreme stretch goal for our team, the strength in the design still remains. Practice mode was viewed positively by all the students we interviewed and we utilized ample research to support the interface design and learning science principles behind it. These can also readily be applied to challenge mode, as it's a variant of the practice mode with a social aspect added to it. An important prerequisite to implementing this challenge mode would be a stable social API, for networking with other students in a course or a user's friends. We know this is already in the works at WGU and look forward to the integration of the app we've developed and other projects going the university has planned.



OUTRO

SLICE CONSULTING

We are a group of 4 Carnegie Mellon University students who are pursuing the Masters in Educational Technology and Applied Learning Science (METALS) degree at the Human Computer Interaction Institute. METALS culminates with a capstone project that is the focus of the spring and summer semesters. In this seven-month project for our external client, WGU, we were able to apply the techniques, theories, and methodologies that our program taught us to deliver a final prototype. We gained practical experience as we worked in a team-based research and development project. We're very pleased with our how far we've come and with our final product, it's been a wonderful learning experience and it's been rewarding to see how far we've come. Thank you to our faculty mentors John Stamper and Bruce McLaren, and our client-mentors Jason Levin and Maria Andersen from your friends Steven Moore, David Hwang, Shailja Relwani, and Samyak Shah!

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