



WPI

AN ALTERNATIVE TO LOCATION BASED MUSIC REHEARSALS

An Interactive Qualifying Project Report completed in partial fulfillment of the Bachelor of
Science degree at Worcester Polytechnic Institute, Worcester, MA

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ABSTRACT

Musicians rehearse with various equipment and systems. These tools restrict rehearsals to specific locations and may hinder a musician's ability to rehearse at their leisure. The goal of this project was to devise a solution that would allow musicians greater flexibility with regard to rehearsal locations. Based on our literature review, we concluded that a mobile application would best facilitate our objectives. We then constructed two focus groups of musicians in order to obtain feedback regarding our prototype designs, and gather perspectives on mobile applications for musical rehearsals in general. Using Grounded Theory research methods, the data collected from the focus group sessions were coded and the emergent themes were used to identify features that were most important to the musicians. We found that comprehensiveness of the application, group sharing and learning, uniqueness of the application, simplicity of the design, feedback of user progress, substitution of manual tasks for digital versions and no or low cost of the application were the most important factors that should be considered in the development of such an application.

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AUTHORSHIP PAGE

The contents of the report represent the combined efforts of Stephanie Arce and William Edor.

TABLE OF CONTENTS

Abstract	1
Acknowledgements	2
Authorship Page.....	3
List of Figures and Tables.....	6
Executive Summary	7
Introduction and Background	7
Methodology	7
Data and Analysis	7
Conclusion	10
Chapter 1: Introduction	11
Chapter 2: Background	13
2.1 Informal and Formal Learning in Music	13
2.2 How Popular Musicians Learn	13
2.3 Technology in Music Teaching	14
2.4 Existing Applications	15
2.4.1 Anytune	16
2.4.2 Rehearsal: App for Practicing Musicians	16
2.4.3 RiffMaster Pro	17
2.4.4 Summary of existing applications	18
Chapter 3: Methodology	19
3.1 Meeting with an Android App Developer	19
3.2 Music community input	20
3.3 African Drum Rehearsal Sit In	22
3.4 Data and Analysis using Grounded Theory	22
3.5 The Swift Language and Xcode	23
Chapter 4: Data and Analysis	26
4.1 Results	26
4.2 Discussion and Analysis of gathered data from focus groups	31
4.2.1 Comprehensive Application	32

4.2.2 Uniqueness of Application	32
4.2.3 Substitution of manual tasks for digitized versions	32
4.2.4 Simplicity of design	33
4.2.5 Feedback of user progress	33
4.2.6 Group Learning	33
4.2.7 No/Low Cost	34
Chapter 5: Conclusions	35
Appendix A - Example of Mobile Application Designs	37
Appendix B - Transcribed Focus Group #1	39
Appendix C - Transcribed Data and Images from Focus Group #2	42
References	48

LIST OF FIGURES AND TABLES

Table 1: Themes, descriptions and corresponding mobile features.	9
Figure 2.1 Anytune Application	16
Figure 2.2 : Rehearsal: App for Practicing Musicians	17
Figure 2.3: RiffMaster Pro mobile and iPad application	18
Figure 3.1: This is a preliminary design and concept for the mobile application.	21
Figure 3.2: Additional example of how the mobile application may work.....	21
Figure 3.3: This figure shows the organization of each screen in the storyboard. The arrows indicate the movement of one screen to the next.	24
Figure 3.4: This shows the relationship between the storyboard and the code. Some code is formatted to control what information is passed through each of the screens.....	24
Figure 4.1: A participant' s design based on the Voice Memo application.....	30
Figure 4.2: A participant's design of the music rehearsal application.....	31
Figure 6.1: This is another design of how the mobile application may be laid out.	37
Figure 6.2: The navigation of saving a selected loop of a song.....	38
Figure 6.3: An example of how the list of applications can be presented to the user.....	38
Figure 6. 4 This is n mobile application designed for the iPad from one participant from the focus group.....	46
Figure 6.5 Another participant's iPhone app using icons instead of text to have a concise and neat layout.	47

EXECUTIVE SUMMARY

Introduction and Background

Rehearsals play a key role in the development of a musician's skill. Research suggests (Green 2002 p.62) that most musicians learn aurally through repeatedly listening to a piece of music and playing back or singing what they heard. Location and equipment availability are also important in the rehearsal process and can limit the rate at which musicians rehearse. For example, band rehearsal on the train may be difficult due to unavailable equipment and conducive environment. This project seeks to develop a mobile application that musicians of varying skill level can use to rehearse anywhere with or without equipment. A mobile application is a very good solution to the problem of location based rehearsing as it can easily provide a feature that serves and reinforces aural learning. Additionally, a mobile application can be leveraged to provide more features that would augment the rehearsal experience.

Methodology

To realize our solution to the problem, we created a prototype design mockup of a smart phone rehearsal app that incorporated the primary features we found common among existing rehearsal apps. We then conducted two separate focus groups of musicians to obtain feedback on our prototype designs and mobile applications for rehearsal in general. Participants of the focus groups were students from the Worcester Polytechnic Institute. The first focus group had two students: a drummer and clarinet player. The second focus group had four students: a trombonist, a violinist, a pianist and a drummer. Each participant was given the opportunity to design and discuss possible layouts for the mobile application.

Data and Analysis

The responses from the focus groups were then analyzed using Grounded Theory. Grounded Theory is a method of developing conclusions based on the systematic analysis of data (Grounded Theory Institute, 2015). With a plethora of ideas and suggestions from the focus groups, this research method enabled us to hone in those suggestions, which were recurring and strongly emphasized by both groups. These suggestions were the themes on which the application would be designed.

To generate the themes, each member of the team analyzed the transcript of each focus group. As they analyzed the responses, team members would simultaneously assign keywords

and phrases formally known as “codes”, in Grounded Theory jargon, to the sections they deemed important. To prevent bias, the team members individually analyzed each transcript and presented their results to the group. Those codes, which repeated in each team member’s submission, were chosen as categories. These categories were then grouped based on their relevance to form themes. These themes are the underlying guidelines on which the mobile application was developed.

The themes that emerged were:

- Comprehensive Application
- Uniqueness of Application
- Substitution of manual tasks for digitized versions
- Simplicity of design
- Feedback of user progress
- Group Learning and Sharing
- No/Low Cost

The table below shows an overview of the various themes and features that can be implemented to satisfy them.

Theme	Brief Description	Mobile Features
Comprehensive Application	All available features are in one mobile application and can access phone's pre-established applications.	Access music library and voice memos. Can be shared across other applications such as Facebook and Sound Cloud.
Uniqueness of Application	Novel and never seen before features	Concert pitch tuner. Pitch pipe. Comprehensiveness of application. Group learning and sharing across other modern platforms.
Substitution of manual tasks for digitized versions	Objects or tasks that a user may need that can be accessed and used on a mobile phone for better versatility.	Metronome. Tuner. Glossary of terms. Looping feature.
Simplicity of design	Organized and concise to provide a user friendly navigation.	Use Tabs. Recognizable icons. Minimal amount of items on screen. Identifiable feature list/ main menu.
Feedback of user progress	Tracking and providing user progress.	Timeline tracking of progress. Real-time comparison of user's play against the actual tune.
Group Learning and Sharing	Opportunities to connect to social platforms to share and collaborate content.	Group creation for application users. Connections to social platforms such as Spotify and Facebook. Sharing feature for looped sections, metronomes, tempos, recordings and voice memos. Update to band/orchestra members' individual copies of sheet music when conductor's master copy is changed.
No/Low Cost	Application must be low or no cost. Range between \$0.99 - \$1.99	Upgrades must be very low/no cost.

Table 1: Themes, descriptions and corresponding mobile features.

Conclusion

We developed a mobile application prototype (see figure 3.3 page 15) to implement the looping feature as our initial feature since it incorporates the aural learning process mentioned by Lucy Green (Green 2002 p.62). Afterward we met with a group of programmers in Professor Manzo's HU3910 Practicum to build upon our project. We shared some of our results that we gathered from the two focus groups with them.

We would like to recommend that subsequent work in the area of mobile applications for music rehearsals should strongly consider implementing features generated in this project. In William Bauer's paper on Music Learning and Technology (Bauer, 2014), he explains SAMR, a model of successful software for music education. SAMR stands for Substitution, Augmentation, Modification, and Redefinition. The themes in this project deeply reflect these pillars of SAMR and provide relevant implementation examples obtained from musicians. Although this application is geared toward informal music learners, the same features recommended in table 1.1 can apply to traditional instrumentalists. For example, informal music players may use the looping feature, metronome and group sharing more often than traditional instrumentalists. Whereas traditional learners may use the tuner, glossary of terms and updates to an individual's sheet music more often than informal music learners would.

Future work on this project should seek to have a larger pool of musicians of both amateur and professional musicians. A possible way to gather more participants is by conducting an online survey. Further study in this area can be on the access to and dissemination of musical content. Teams can consider legal ways to enable users have access to a wide plethora of music to share and rehearse with in order to boost the group learning effect.

CHAPTER 1: INTRODUCTION

Where do most musicians rehearse? Answers that may come to mind are home, studio, church, school, and other physical locations such as these. This means there are very limited opportunities for musicians to rehearse outside of these physical locations. What if we enabled musicians to rehearse on the train, bus and airplane by use of a mobile application? This will open up many more opportunities for rehearsals and remove location constraints. This project seeks to study the target audience for such a technology and develop prototypes to this effect.

With the evolution of technology, specifically the mobile phone, we are able to carry our music with us everywhere. For practicing musicians, this is a dramatic change as recordings of songs were very limited a few years ago. As a result, practicing or listening to a particular piece of music is easier today.

Aside from recordings, musicians also used sheet music. This provided for visual learning and interpretation of the music. Research has shown that musicians generally have two approaches when learning music. Musicians either learn spatially, by interpreting the notations on a sheet of music or aurally, by listening to the sound of a particular song and mimicking what they hear. For musicians that learn by ear, listening to recordings of music is essentially the only way they are able to rehearse. It allows them to play music sections of interest multiple times and either play along with the recording or to pick up more details of a song.

Most popular musicians, especially those that practice with sheet music, learn specific songs by slowing down the tempo of a song and gradually increasing the speed until they are up to par with the original tempo of the song. Audio players do not provide this feature. A musician that rehearses visually is able to mark up their sheet music to locate a particular part in a song that they want to practice. A musician that plays by ear does not have this leisure as they would have to stop the song and keep track of the time location of the section of interest. It would be much easier if they could identify the part they wanted to loop over once and even save it for future use.

Most musicians today rehearse by ear and informally through cultural experiences. This category of musicians constitutes beginners, amateurs as well as professionals. This form of learning requires listening and copying or playing what you heard. (Green, 2002 p.62). A mobile

application stands out as a solution to aid such musicians augment their rehearsals, rehearse in any location as well as in the absence of an instrument. This solution also provides ways to create strong feedback systems that can help these musicians track their learning progress.

Currently there are very few musical applications on a mobile phone tailored to the needs of musicians who play by ear. Before considering possible designs for the mobile application we evaluated other mobile rehearsal applications that are already on the market. We also conducted two focus groups to gather feedback about how these musicians already practice and how our mobile app can further help and improve their rehearsals.

Our mobile rehearsal application includes features such as being able to identify and store specific music parts from a song and it allows the user to be able to further edit the selected part by slowing down the song or altering the pitch. The results obtained from the focus group provided more features that can be included in the application. These features have been recommended for future implementation.

CHAPTER 2: BACKGROUND

2.1 Informal and Formal Learning in Music

A study conducted on the methods popular musicians learn by sought out a new approach of using informal learning techniques to the classroom. Traditionally, musicians that perform in an orchestra practice in a formal setting in which an instructor guides and critiques individuals or a group of individuals. In more formal rehearsals, the instructor schedules the practice times and the instructor also determines what is to be performed or rehearsed. The main difference between formal and informal practices is not in the difference between reading sheet music or learning by ear, but rather the setting in which rehearsals are conducted. Formal learning is structured around a seasoned musician mentoring and guiding an amateur musician, whereas informal learning is peer-based (Green, 2002, p.6).

Informal learning is characterized by, the music that is practiced is chosen on preference, the music learned is through listening, and individuals learn with friends and have no structural guidance (Green, 2008 p.23). Details or patterns are not given or referred to by their technical terms in informal learning. Yet, aural musicians still demonstrate the same understanding of the “theory” or importance of how certain details affect music. An example of this is how individuals that can play by ear are able to recognize chord progressions. A chord is a group of harmonizing notes and a chord progression is a group of chords that follow a scale such that the scale specifies the order of the chords. Musicians that learn aurally are able to pick up on these chord progressions and even predict which chord will be next. This is something amateur musicians who practice informally do not consider to be technical; rather, it is based on a theory that one can learn intuitively. Both informal and formal techniques of learning are to improve one’s musical ability.

2.2 How Popular Musicians Learn

One of the key characteristics of learning music, regardless of learning by ear or sheet music, is listening. In Green’s studies she interviews two musicians, one a beginner at 16-years old and another older musician in a band, both of them say that when they practice they play things that sound good to them without knowing what it is they are doing. For, example the 16 year-old musician says that when she is practicing guitar with an amp she doesn’t, “know what they do, so I spend time just twiddling them and seeing what sounds good” (Green, 2002 p.22).

Jay Dorfman in “Technology- Based Music Instruction” also states that, “jazz pedagogy students learn to improvise by listening to the improvisation of masters” (Dorfman, 2013 p.55). In music our ears are the only sense we have to detect whether what we are playing is accurate and it is the only sense we use to create music.

Green states in her book that there are three types of listening, purposive listening, attentive listening and distracted listening. While purposive listening and attentive listening are similar, purposive listening is to learn specific details of a song in order to play a song more accurately, whereas attentive listening is aimed to learn something in order to play, remember or to describe afterwards. As for distracted learning, music is purely for enjoyment. Cover bands are an example of those that utilize the three different types of listening. In Green’s interviews with those that are in bands many of the musicians mention that they initially learn a new song by listening to other people and copy them. They explain the process as repetitively listening to a single section of a song over again until they are able to play or sing it (Green, 2002 p.62). She extends the process as describing it as a “constant process of listening, internalizing, practicing, listening and playing along” (Green 2002 p.62). This process is crucial to those that learn by ear and those that play with sheet music because it allows for the individual to recognize the style and details pertaining to a particular song.

2.3 Technology in Music Teaching

Technology has integrated to our normal everyday lives and has now become an increasingly popular attribute to education. In a recent article by William Bauer, he mentions specific attributes that any software needs to have in order to be successful in the integration of music learning. The model in which Bauer refers to as the SAMR for short includes the four principles of a successful software which are substitution, augmentation, modification and redefinition.

Enhancements for music education are achieved by the two principles of substitution and augmentation. In substitution, the device “... substitutes an older tool or approach of doing something” (Bauer, 2014). Augmentation is defined as not only substituting an older tool but “... adding functionality not previously available” (Bauer, 2014). These are the very basics to any digitalized application for it allows the tool to be easily accessible and can be of low cost. An example given by Bauer is a metronome. A digitalized metronome on a phone is capable of

performing just as well as an analog metronome, i.e. using the attribute of substitution, but in a digitalized metronome one can also allow for subdivisions or a different timbre for the metronome sound providing for a function that wasn't available in an analog metronome thus using the principle of augmentation.

Modification and redefinition enable the transformation of music education. Modification is a principle in which the “learning task is completely redesigned” (Bauer, 2014) whereas redefinition is a principle of “engagement of new tasks not previously possible” (Bauer, 2014). These attributes are best explained by a software called SMART Music in which students can hear the metronome click play along with “musical accompaniments to practice performing tempo” and can also give “visual feedback regarding rhythmic accuracy” (Bauer, 2014). Allowing a musician to gather visual feedback of the rhythmic accuracy renovates the music education of simply allowing for our hearing to be the only sense of detecting whether we are playing something accurately or not.

Dorfman also mentions that in order for any software to be successful in terms of user interface and design, the user should be able to “quickly recognize what the components of the software are capable of doing” (Dorfman, 2013 p.66). User interface should be as intuitive as possible to the user and allow for the user to easily access the features especially if a software has a purpose of substituting or augmenting a previous tool. Otherwise, if the user interface allows for more trouble than simply accessing the old tool, then the software may not be as successful. Another feature any software should consider is its extensibility, which is how the features included in the pack would be able to be accessible to other music programs or software (Dorfman, 2013 p. 66). For example, if a piece of music is created in the software package can the piece of music be accessible by an individual's music player. These features are important consideration when designing a music application to help redefine music learning or rehearsals.

2.4 Existing Applications

Before we started the design process for our own mobile application, we first researched different mobile applications already on the market. We reviewed each of these mobile apps based on their cost, ease of use, their respective user interface designs, and the reviews from musicians that have used the application.

2.4.1 ANYTUNE



Figure 2.1 Anytune Application

Image obtained from <http://anytune.us/products/anytune-for-ios/>

Anytune is both a mobile and PC software for Apple products only. This music rehearsal application is designed not only for musicians, but also for singers and dancers. The Anytune app is able to slow down a song, adjust the pitch of the song, play music from your own music library, and is able to save looped parts. Along with these features, the Anytune app allows users to record and share music, import audio from videos, and download songs from the Web. Even though the Anytune app has many beneficial features for artists in their rehearsals, the price ranges for purchasing the basic features to the pro features from \$1.99 to \$14.99. A problem with this application is that the price range is high, serving as a possible deterrent to amateur musicians. Upon reviewing the application from a web source, App Crawlr, a majority of the people that have used the application thought it was very useful, and overall a great app to use but many of them had complaints about the price of the app. Other comments on this app have been on the complexity of the user interface. The layout of the app on an iPhone, for example, has been mentioned to be too cluttered and presenting too much information.

2.4.2 REHEARSAL: APP FOR PRACTICING MUSICIANS

Rehearsal is a concept design a student created for their capstone project. The tablet application was designed to help musicians practice regardless of whether they read sheet music or not. Its essential goal was to increase musical comprehension and improve a musician's performance. The app targets the two different types of musicians, those that practice visually with sheet music or musicians that practice by ear and memory. The app has several features

including one that enables musicians who practice visually, to compare what they play to the actual sheet music. Also it allows the user to loop through a part of a song and annotate the sheet music. This app also allows the user to record and edit songs in their song library as well as compare tracks visually. The Rehearsal app also sought to bridge the gap between audible and visual musicians by including music exercises on music theory, interpretation of sheet music, ear training, and improvisation with a given rhythm. Although the application is not out in the market the design is simple and easy for any musician to use for their rehearsal.

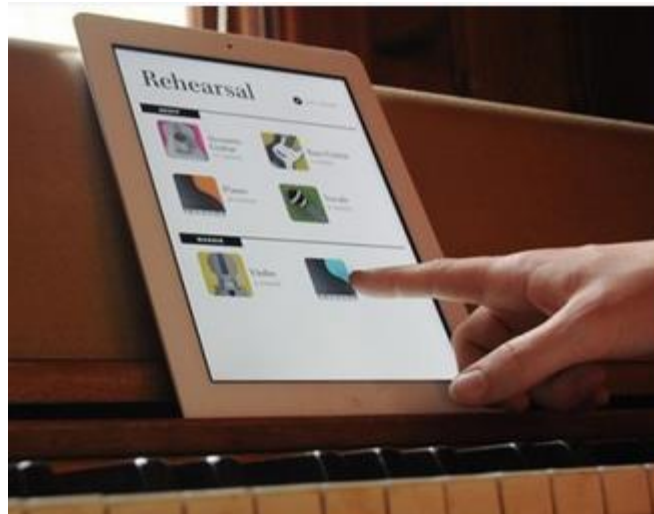


Figure 2.2 : Rehearsal: App for Practicing Musicians

Image obtained from <http://awards.ixda.org/entry/2013/rehearsal-an-app-for-practicing-musicians/>

2.4.3 RIFFMASTER PRO

RiffMaster Pro is a mobile and PC based music application. Its central targets are guitarists though its features are applicable to other musicians and vocalists. It works by allowing the user to section a part of a song and perform various tasks. These include, looping multiple times over the section; slowing the song down, note for note, without changing the pitch and changing the key of the song section. Its slow-down function enables the user to gradually learn the intricacies of a song at a slow rate and build up speed as they increase their mastery over it. This is all at the control of the user. There is no sheet music used, so the primary learning style of users would have to be 'by ear'. The creators of the application cite this as a useful skill the application helps user acquire. The application is also able to work with many popular file formats including mp3, wav, wma and mp4. The user interface is simple and allows the user to quickly maneuver their way around the application. The cost is \$8.99 for the mobile version and

\$49.00 for the Mac version and Windows PC versions. For users who rehearse using laptops and PC systems, for example band groups, this cost may be an issue. Online reviews of the product have largely shown customer satisfaction and admiration. For this project, our team may look at and learn from the successes of this application.



Figure 2.3: RiffMaster Pro mobile and iPad application
Image obtained from <http://riffmasterpro.com/iphone-ipad-riffmaster-pro/>

2.4.4 SUMMARY OF EXISTING APPLICATIONS

Each application has its unique qualities and down sides. Overall, they all provide features that help aural and visual learners. As this has been stated earlier as the common learning styles of musicians, it explains why the applications resort to features that aid aural and visual learning. On the side of cost, the applications are ranging from \$1.99 to \$49.00. Our goal as a team would be to incorporate the features that stand out from the applications and aim for a very low price range.

CHAPTER 3: METHODOLOGY

One objective of this project was to create ways for musicians to practice regardless of location. Based on our literature review, we concluded that a mobile application would be the best way to do this due to widespread use of smartphones and the wide acceptance of the mobile applications we researched earlier, by the music community. The expertise of Professor Emmanuel Agu, a Professor of Worcester Polytechnic Institute and a mobile application expert, was sought to educate us on best techniques and platforms to use for building the mobile application.

Next, we organized two focus groups of a total of six musicians whose skill set ranged from beginner to intermediate levels. Through a series of questions and interactions, we obtained insight into the usefulness of a mobile application for music rehearsal and key features to include in the application. The results of the focus group meeting were then analyzed using Grounded Theory. This research method was used to generate core themes from the focus group results. These themes were the key factors we considered and recommended in the development of the mobile application. A prototype of the mobile application was also built using Swift language in the Xcode environment. The various steps we undertook are listed and explained in more detail.

3.1 Meeting with an Android App Developer

As novice iOS programmers we sought the help of Professor Emmanuel Agu, a fellow WPI computer science professor who has experience in creating Android apps. In our interview with Professor Agu, we explained our goal of creating an iPhone app to help aid musicians in rehearsals. We discussed good programming techniques and any tips to learning object oriented programming languages. A couple of suggestions were to invest in a good programming book that is easy to understand to help guide us through our app and to look up any online courses such as Udemy to follow along and experience hand on learning, or to find other computer science students to help teach principles that we may need for our mobile application.

Concerning our focus group, Professor Agu suggested that we have our participants build their own sort of mobile application by either having them draw what they would like to see or by having cardboard cutouts of different parts of the app and have them arrange them. By doing this we will gain valuable information of what users would find not only easy to use but what layout is comfortable to the user.

3.2 Music community input

Considering the plethora of musicians and the different learning styles and skillsets they have, our team had to decide who the target group of the application would be. To that effect, a focus group was organized. The opinions expressed by the focus group would also inform the team on important features to consider in the development of the application. The participants were amateur musicians, who were largely university students. Two focus group meetings were conducted with a total of six participants. The reasoning behind this was that, too little a number was an inadequate representation of the music community and too large a number may hinder an interactive environment where ideas could easily be shared and conclusions quickly reached. A broad range of questions were asked in order to obtain enough information from musicians. The questions are listed below,

- What materials do you rehearse with?
- Where do you rehearse?
- How do you rehearse?
- Do you rehearse with others or alone?
- What mobile interface do you use (iOS or Android)?
- Would you like to see this app on your cell phone, tablet or laptop?
- Do you think an app can benefit your rehearsal and how?
- What features would you like to see in the app?
- How much are you willing to pay for the app?

The same information and the questions that were outlined above were asked in both focus group meetings. Each session had different participants and was recorded after asking for their consent. Responses from the participants were written down as data for subsequent analysis and discussion. Based on the recommendation from Professor Agu, we had the participants also draw

on an iPhone template of how they might see the app laid out in front of them. As a way to help guide our participants to design application templates we provided images of preliminary mobile application layouts in PowerPoint we had designed.

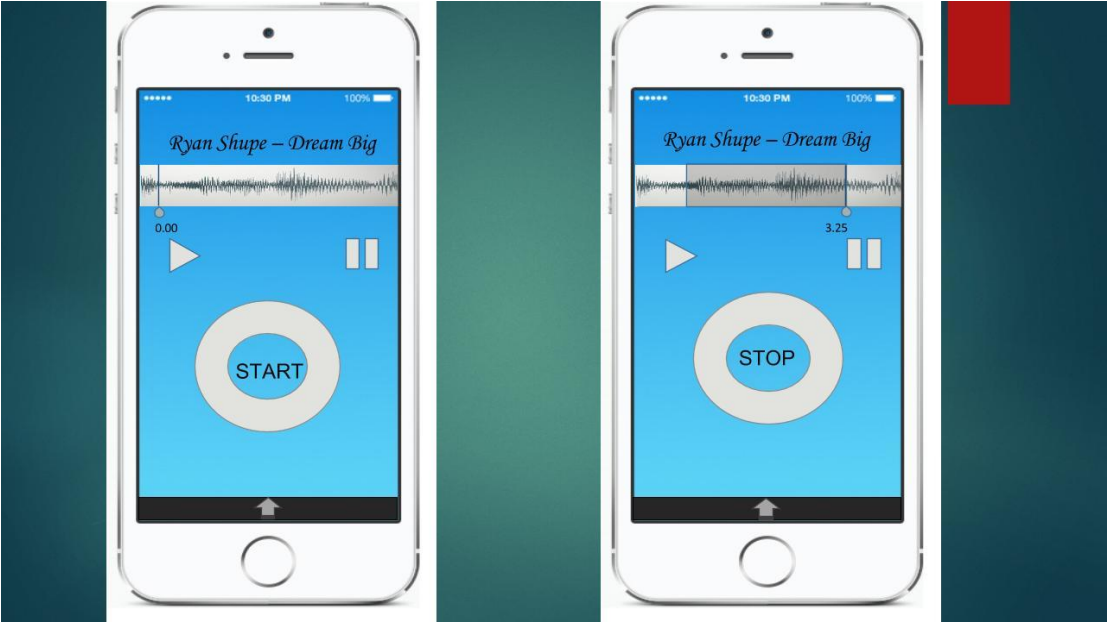


Figure 3.1: This is a preliminary design and concept for the mobile application.

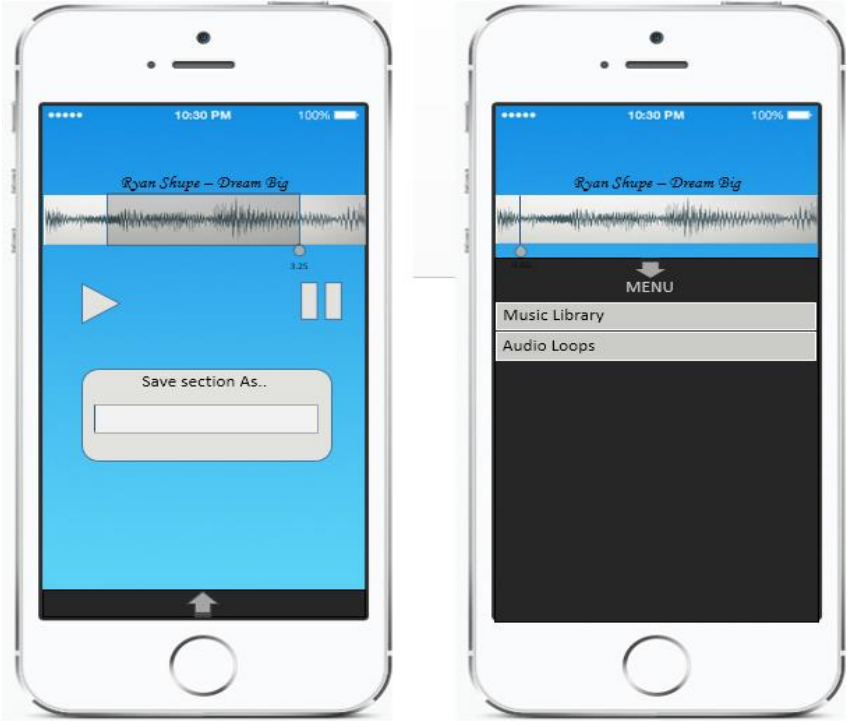


Figure 3.2: Additional example of how the mobile application may work.

As the focus group meeting was an open-end discussion we believed this approach would enable us to truly engage the participants and obtain visual ideas and insights they may have not been able to fully verbalize.

3.3 African Drum Rehearsal Sit In

After we gathered information from the focus groups, we believed that we might be able to benefit from observing an informal musical rehearsal. We chose the African Percussion and Dance Ensemble as our music rehearsal group because even though there is an instructor, they use vocables as a way to help learn music instead of the traditional sheet music. In the rehearsal, any musical parts that were new to the students were first vocalized by the instructor to allow the musicians to hear how the part was played. Afterward, the instructor continued by breaking the part into smaller sections and vocalizing them as a looped call and response. Once one section of the part was grasped by the students, the instructor would add another section and they would continue looping through the part until everyone was capable of playing the part. Then once everyone was comfortable, each student played the different instrument that they had already practiced in their parts. They all do not begin together but rather, each of them first vocalized their individual parts before playing them on the drum and then began playing their drum parts when they felt comfortable.

From the rehearsal we were able to indicate that the loop feature that we first were presented with would be advantageous to musicians that are rehearsing by ear. Also another feature that may be advantageous is a metronome, so that the musicians can have a feel of the pulse to know when to come in and feel the rhythm. Another feature that we noticed could be of use is being able to share the vocables and recordings to each member of the group so that there is consistency between the group and can later be practiced individually or listened to at the musicians own free time.

3.4 Data and Analysis using Grounded Theory

Grounded Theory is a method of developing conclusions based on the systematic analysis of data (Grounded Theory Institute, 2015). There are detailed methods that one employs when using grounded theory principles to analyze data, including coding, memo-writing and theme generation. In coding, the researcher sorts the data by assigning keywords and short phrases that summarize the import of the data. Memo-writing has the researcher performing initial analysis of

the codes that have been generated and observing codes that begin to form theoretical categories (Charmaz 2006). The memo writing stage is iterative and lasts throughout the research process. The final step is theorizing from the codes and memos, which have been generated in the research process.

For this particular project, we generated labels and keywords for the focus group responses. In order to make the results from this stage unbiased, each member of the team individually came up with the keywords for responses from each focus group. The individual submissions were then collated and then discussed by the entire team. The team then selected keywords that were recurring in each team member's submission. These codes were discussed in-depth and grouped into categories based on their intrinsic themes. These categories were the finalized themes generated from the analysis of the focus group data. These themes then provided the important features to implement in the mobile application as well as recommendations for further study and work on this project.

3.5 The Swift Language and Xcode

To implement and create our mobile application, we used the Swift language, a relatively new language that makes the iOS development process easier for novice programmers such as ourselves. This language is a combination of C and objective-C languages to help programming become as intuitive as possible. The Swift language uses a lot of built in function libraries to make the process of coding easier. Instead of coding the playback function of a song from scratch, the function of opening and reading a song file, is already stored in a separate function and can be called upon in one single line.

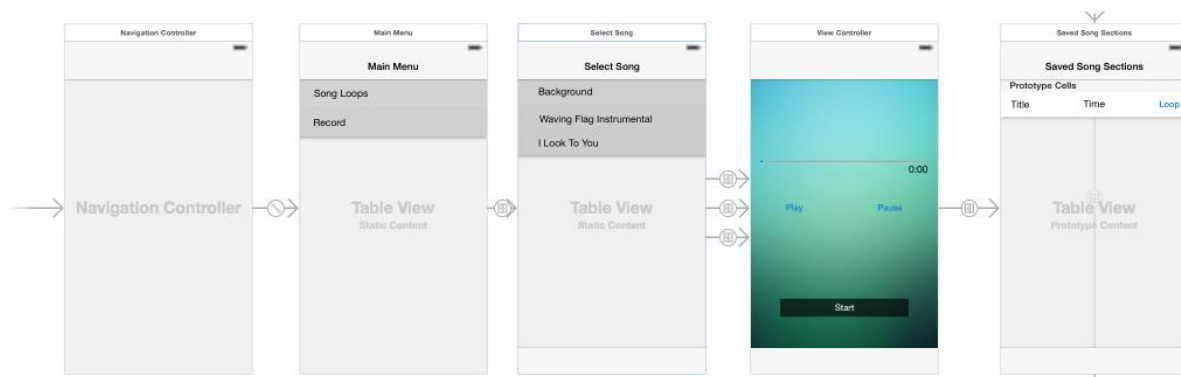


Figure 3.3: This figure shows the organization of each screen in the storyboard. The arrows indicate the movement of one screen to the next.

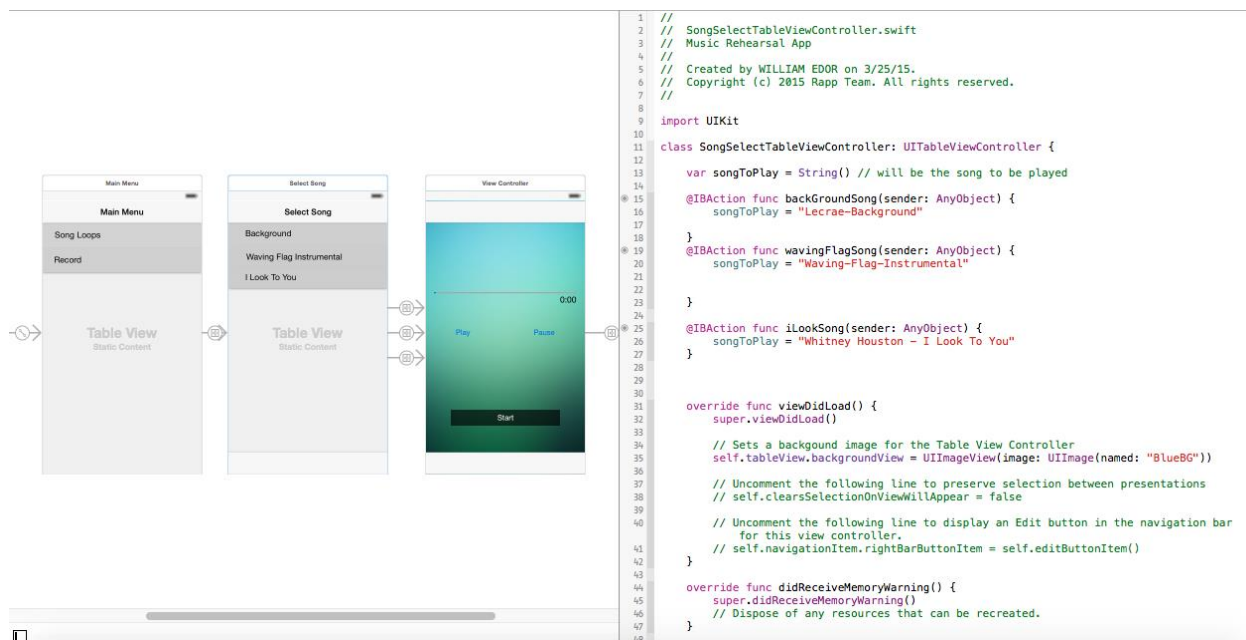


Figure 3.4: This shows the relationship between the storyboard and the code. Some code is formatted to control what information is passed through each of the screens.

Xcode, is a Mac based software that utilizes the feature of a storyboard and supports the swift language as well as the objective C language. This software makes it very easy to design the layout of each screen that is in the app, while also being able to organize the sequence at which each screen will appear depending on the action of the user as seen in figure 3.4 above. Being able to visually see how our layout looked, not only saved time but made it easier to focus all the coding to creating the desired features such as playing a song, looping through a song and

so forth. Just like any other programming software we are able to run our prototype with an iPhone simulation to test the performance and functions of our design. With the, Xcode software, we are able to easily create a prototype that can later be coded for working functionality.

CHAPTER 4: DATA AND ANALYSIS

4.1 Results

As was noted in the methodology section, two focus groups were conducted. The responses from the first group will be enumerated first followed by that of the second group. After this will be the discussion and analysis of the responses. In the first group, the answers on the first question about the materials the participants used in their rehearsals came out to be stands, chairs, instruments, bells, rattles and drums. When participants were asked about the location of their rehearsals, they mentioned rehearsing in Alden Memorial when school was in session and at home when school was not. Along with the location, participants talked about rehearsing individually as well as in-group sessions at home or in school. This response satisfied the question about the people count during participants' rehearsals. When asked about whether they rehearsed without instruments, participants mentioned vocalizing before performances and visualizing clarinet fingerings as a way of practicing when the instrument was not at hand. The participants were then asked to talk about their preference on mobile devices. All responses favored Apple iPhone and iOS over Android and other mobile platforms. Within the Apple device family, some participants also mentioned iPads as a mobile device of choice. This was noted and its implication would be discussed later in this section.

Next, the members of the focus group were asked about possible features they would like to see in the application. The responses were a metronome function to keep timing, a pitch pipe function that would enable vocalists to listen to a desired pitch in the absence of an instrument, a tuner function for tuning instruments, a thermostat which will enable vocalists to be cognizant of the temperature leading to better vocal care, a humidity gauge to especially help musicians with wind instruments be cognizant of the humidity and how it affects corks and instrument sound outputs as a result, and a concert-pitch-to-instrument-pitch function that would enable musicians to convert from concert pitches to the pitches of their instruments.

The participants were then asked to talk about their opinions on the usefulness of a mobile application for augmenting rehearsals. The members noted that if features such as the tuner, metronome and concert-pitch-to-instrument-pitch were implemented that would be make a mobile application for augmenting rehearsals very useful. When asked if they envisioned an application that worked with them or performed complicated tasks on its own, participants

mentioned that they would prefer an application they would work with. They noted that the application did not have to be complicated to do everything and that they would probably use it more if it did simpler tasks. They mentioned that an application with too many items on display could throw a potential user off.

We then showed the group an example of an application layout in PowerPoint and asked for their comments on it. They mentioned that a recording feature would be a great addition to the functions of the application and would also be one of the features they would use a lot. They commended the simplicity of the layout and the usefulness of the pop-up menu button and sub group nature. To add to the design, they advised a simple color scheme as too many colors and fancy colors were mostly tied to being novice and unprofessional. One participant mentioned that she was wary of using such applications and did not pay to use them. Participants also mentioned the fact that most wildly colorful applications were associated with. Participants also mentioned choosing a one worded name as a verbose name would likely not lend itself to word-of-mouth propagation. Examples of famous one-worded applications such as *Twitter* and *Facebook* were cited. Participants also suggested choosing a name related to music to enable potential users easily find or come across it in the Application store and other online avenues.

Participants were also asked about their impressions on a connectivity and sharing feature in the application. They expressed how that feature easily lent itself to being used together with the recording feature. In this regard, a section of a song or recording could be sent to another person. They mentioned that usage for this purpose would make the proposed sharing feature one of high value. They also mentioned that it could be added to the menu section and also allow users to share information with other users. They also mentioned the feature can allow for user groups where content could be shared among participants similar to the Sound Cloud platform.

In the same vein, the participants admonished that the application should connect with applications and platforms already used by majority of people. Examples of such platforms are Sound Cloud, Spotify, Facebook, and so on.

Some individuals from the focus group asked if the music application would connect to the phone's library or would have a bank of songs it accesses. Our response was that our initial designs were being tailored to allow the user to access the songs on their phones. However, the

decision on whether a user will be able to save section of songs or recordings to their phone libraries or to a database in the application had not been decided yet and was still being explored. The participants mentioned that the application should connect to the voice memos also as that would be a useful feature for singers.

On the topic of cost of the application, some participants mentioned that they would expect to pay a maximum amount of \$0.99 as payment for the application. However, they mentioned that if the application performed sophisticated functions, they would be willing to pay \$1.99, which the participant noted as the usual amount for most mobile applications.

Finally, the group was asked if they envisioned outgrowing the application as their ability improved or if they would still use the application in their professional music careers. The group members said they would still use it depending on the uniqueness of the application, cost and if it was the only one of the market that did certain functions. They also said, ease of use would be another factor they would consider.

In the second focus group, when we asked participants what they rehearse with, one person had said that they rehearse with a metronome due to the fact that the participant played drums. The participant also mentioned that if they were to have a metronome application, it would help aid in their rehearsal while also stating that there are probably metronome applications out on the market but if it were to be included into one single application with many features then it may more useful. The other three participants also agreed that having one mobile application that includes all features would be useful. When the group was asked whether having a metronome playing in the background of a song as they're playing would be a feature worth pursuing, the group said that it would be a "cool" idea. Another participant mentioned that musical terms pertaining to tempo such as the terms *adagio*, *allegro*, or *lento* are not intuitive and have to be looked up. The participant mentioned that it would be useful to have a glossary of terms readily accessible to look up unknown terms. When we mentioned whether having a separate recording device in the app or one already installed in the phone, a participant also mentioned the ability to record himself or herself. One participant also pointed out that voice memo is not good for high quality recording.

As the focus group progressed the group was then asked if they were to play with a group would they like to have the audio accessible to everyone on some sort of cloud. One participant mentioned that it would be a good idea in terms of everyone having the “same thing” but that not everyone may have a smartphone. Another participant mentioned that he would like to have a track of changes in a “time format” especially when it came to the conductor’s baton movements.

When the group was asked if they would like to see the mobile application on their cell phone, iPad, or laptop, many agreed that the cell phone is the most convenient way. One participant said that the tablet and cell phone is a good size to have on their music stand but a laptop is less preferable. In asking the group how much would they pay for the application, one participant mentioned that they would be willing to pay a couple of dollars but expressed their concern that many people would not pay for anything. Another participant said that they would only pay if the application had a feature that no other application can do especially if the music application is accessible on their cell phone.

After our discussion questions we then asked the participants to draw a design of the music application using iPhone templates printed out for them. We also then asked the participants to explain their design to us. One participant based their design on the voice memo application on an iPhone because it had a nice design. The participant mentioned that the design was straightforward and that is why it would make the application easier to use. In the participants’ application, seen in figure 4.1 below, there is a moving recording bar and you may have a metronome that can play on top of the recording or have the option to have a separate music and tuner option.

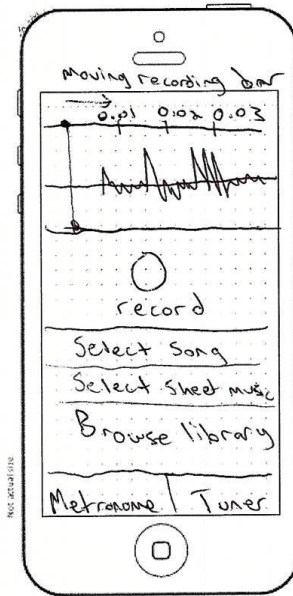


Figure 4.1: A participant's design based on the Voice Memo application.

As for another participant's design (see figure 4.2), they mentioned putting the functionalities across the top of the application such that they could swipe across the top bar in order to have quick access. The participant also mentioned that they would have markers to see where they would want to loop across a song.

Another participant based their design on an iPad, in which some functions are separated by different tabs such as selecting your own sheet music, a recording tab for video and audio, an account, and an assessment tab. As for the sheet music tab, there are functions such as starting a metronome that is automatically generated based on the tempo marking or terms of tempo. There's also a function of auto scroll, in which the scroll bar moves in time with the metronome, while also tracking any differences in the individual playing and the master copy. The screen is also zoomable to allow for an individual to see the sheet music better. Another feature is that in the assessments tab you are able to record yourself and get feedback on the differences between an individual's recording and the song in your music library.

In another participant design, when asked to share, the participant described the icons and what each one represented. Such as the books icon representing the music library, and allowing an individual to gain access to songs on their phone. The participant also described the pencil icon to be for editing their sheet music, the clock icon as the metronome, and the filled in circle

to be used for recording. In order to make more detailed changes in recording or sheet music the participant included another option button so as to keep things separate and neat.

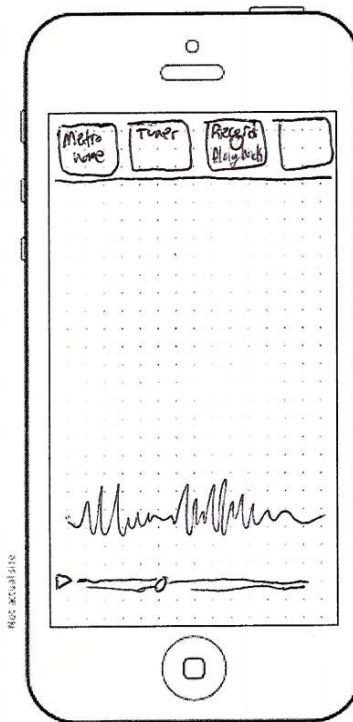


Figure 4.2: A participant's design of the music rehearsal application.

4.2 Discussion and Analysis of Gathered Data from Focus Groups

The information obtained from the focus group were then analyzed to obtain data that to be used in the development of the mobile application. Grounded Theory was utilized as the primary analysis tool. The themes that were generated using this research method were:

- Comprehensive Application
- Uniqueness of Application
- Substitution of manual tasks for digitized versions
- Simplicity of design
- Feedback of user progress
- Group Learning
- No/Low Cost

4.2.1 COMPREHENSIVE APPLICATION

Upon analysis of our data, we observed that in both focus groups, our participants responded that they would like to have all features or tools in one place. In both focus groups participants responded similarly with having the features and tools “together” or “in one whole place.” Within the theme of comprehensiveness is also the idea that any mobile application should allow the user to also access the parts of memory or existing applications already set in an individual’s own mobile device. As mentioned by Dorfman’s work (Dorfman, 2013), it is important for the integration of technology in learning to also be compatible with other applications. A couple of our participants had mentioned that the music rehearsal application should not only have access to a phone’s music library or their voice memo. This way all features are accessible in one convenient place and can be accessed at any given moment.

4.2.2 UNIQUENESS OF APPLICATION

It was noted that participants from both focus groups repeatedly hinted on the uniqueness of the application. They mentioned this factor as the reason why they would continue to use this application even when as they advanced in musical abilities and skillsets. On the topic of using the application as their skills improved, a participant was quoted to say “As long as you were doing something different, I would use it”. This was the reason why “Uniqueness of application” is considered as one of the categories which needs to be strongly heeded to in the development of the application. Other categories such as Comprehensive Application, Substitution of manual tasks for digitized versions, Feedback of user progress as well as Group Learning and Sharing also support this theme of “Uniqueness of Application”.

4.2.3 SUBSTITUTION OF MANUAL TASKS FOR DIGITIZED VERSIONS

As participant described features that they would like to see in the mobile application, many had mentioned that they would like for the mobile application to be able to do tasks that would have taken longer if done manually. Such an example is how one participant mentioned that they would like to have a glossary of terms of tempo markings or to have them already translated. Mentioned before by Bauer, the augmentation of manual tasks is one way of incorporating technology into the music rehearsal process. This allows for individuals to run their rehearsals more smoothly with instantaneous results and access to answers and tasks they need.

4.2.4 SIMPLICITY OF DESIGN

As a general concession in both focus groups, participants had described that the design should be “simple” or “pretty straight forward or being “basic.” All these codes fit into the theme of simplicity of design. As people described their design, many had based off their design from pre-existing apps that they have become accustomed to. For example, one participant mentioned that they had based their design from the iPhone voice memo. To follow along with the theme of simplicity of design, one participant had used recognizable icons as a means of organizing different sections. Since an iPhone has a small screen area, using such icons can take up less space than words and can optimize screen space. As for organization in this theme, different tabs or icons allow for the user to not only easily navigate the application but to also recognize immediately what features will be available.

4.2.5 FEEDBACK OF USER PROGRESS

Participants also mentioned that the application provide feedback of the user’s progress. This factor is tied to the learning features of the application, for example the tempo sensor. The participants requested that this feature have ways to inform the user if they were playing the right tempo and tell them how much they had improved in playing the right tempo of a particular tune. This could be done through the application comparing a recorded version of the user playing the song to the actual song and providing results that would show the comparisons and similarities. Another form of feedback was demonstrated by a participant from the second group who drew a design for an iPad that had an auto-scroll feature that showed the differences between the master copy of the sheet music and what the individual was playing in real time. This is also an example of feedback. This feature could also be very helpful for users who were vocalists.

4.2.6 GROUP LEARNING

Another recurring theme was a group learning and sharing feature. Participants mentioned that the application should be able to connect to social platforms such as Facebook and Spotify. It can be noted that these platforms are well-established social networks. We realized that the participants were asking for ways to collaborate with other musicians through these platforms. Collaboration would be through sharing sectioned part of the songs, tempos, metronomes and so on. Another facet of group sharing would be with the sheet music iPad application. The participant mentioned a way to update the sheet music of all the individuals in the band/orchestra with changes from the master list. For example, if the band conductor made a

change on the master copy of the sheet music, the change should reflect on the copies of the individuals in the band/orchestra.

4.2.7 NO/LOW COST

One topic that was also of great import was the issue of cost. The users mentioned that the cost of the application should be within the cost of an average application on the market today, which is \$0.99. Some also mentioned that they would be willing to pay a bit more that is \$1.99, if the application had unique features. Cost was therefore chosen as a theme because it was deeply connected with the features that were implemented as well the acquiring and retaining users for the application.

CHAPTER 5: CONCLUSIONS

A musical rehearsal application would be very useful to musicians of various skill sets. From the two focus groups we conducted, we developed themes that musicians would want to have in a mobile application. These themes with their descriptions and corresponding mobile features are enumerated in Table 1 on page ix of this report.

It should be noted that these feature recommendations agree with posits presented by William Bauer in his paper, *Music Learning and Technology* (Bauer, 2014). As mentioned before, the underlying theory of “substitution of manual tasks” is part of the SAMR model that constitutes the use of technology in a learning environment.

As rehearsals are meant to improve on one’s skill through learning new techniques and musical patterns, we suggest for the rehearsal application to allow the user to take advantage of multiple tools such as a metronome, tuner, looping feature and glossary of terms. It should also be noted that this application can be used by both informal learning musicians and traditional instrumentalists. Whereas an informal learning musician may take advantage of the looping feature and the metronome, a traditional music learner may have more use of the glossary of terms and updates to an individual’s sheet music.

For the feedback feature, we will like to suggest that the feedback results be presented in a way that is easy for the user to digest. The participants emphasized on simplicity, so it would be very beneficial if the feedback data can be presented in a simple and easy to understand manner. The group-sharing feature should also be strongly considered in future developments and upgrades of the application, as it would provide widespread adoption of the application and may create a network growth effect.

In terms of design, simplicity and organization are important to the user experience. As expressed by the participants in our focus group and mentioned by Dorfman (Dorfman, 2013), the application should be easy to navigate so the user can identify what features are available to them. Further study may be conducted for an ideal design.

One issue the participants brought up that was not fully addressed was the sources of the songs that the mobile application would have access to. Further studies can be conducted to determine if songs should be from the user’s phone library and/or music-playing websites such as Spotify and Sound Cloud. Another topic to study would be copyright issues that may arise

with regards to sharing looped music, recordings and other forms of music over social platforms such as Facebook, Spotify and Sound Cloud.

At the end of this project we met with a group of computer programmers in Professor Manzo's HU 3910 class who were going to build upon our mobile application. We shared with them some findings from both of the focus groups to give them direction in the development of the music rehearsal application.

Rehearsals play a crucial role in the development of every musician. Mobile rehearsing applications provide new tools that improve the rehearsal experience. We therefore believe there would be more advancements and research in this area of study.

APPENDIX A – EXAMPLE OF MOBILE APPLICATION DESIGNS



Figure 6.1: This is another design of how the mobile application may be laid out.

In this design of the mobile application we have a button which changes from start to stop when the user identifies at which section to begin saving to later be looped or manipulated further according to available features. In figure 6.3, the menu button swiped out from the right so as a way to not be in the way of a task and can be called upon when needed.

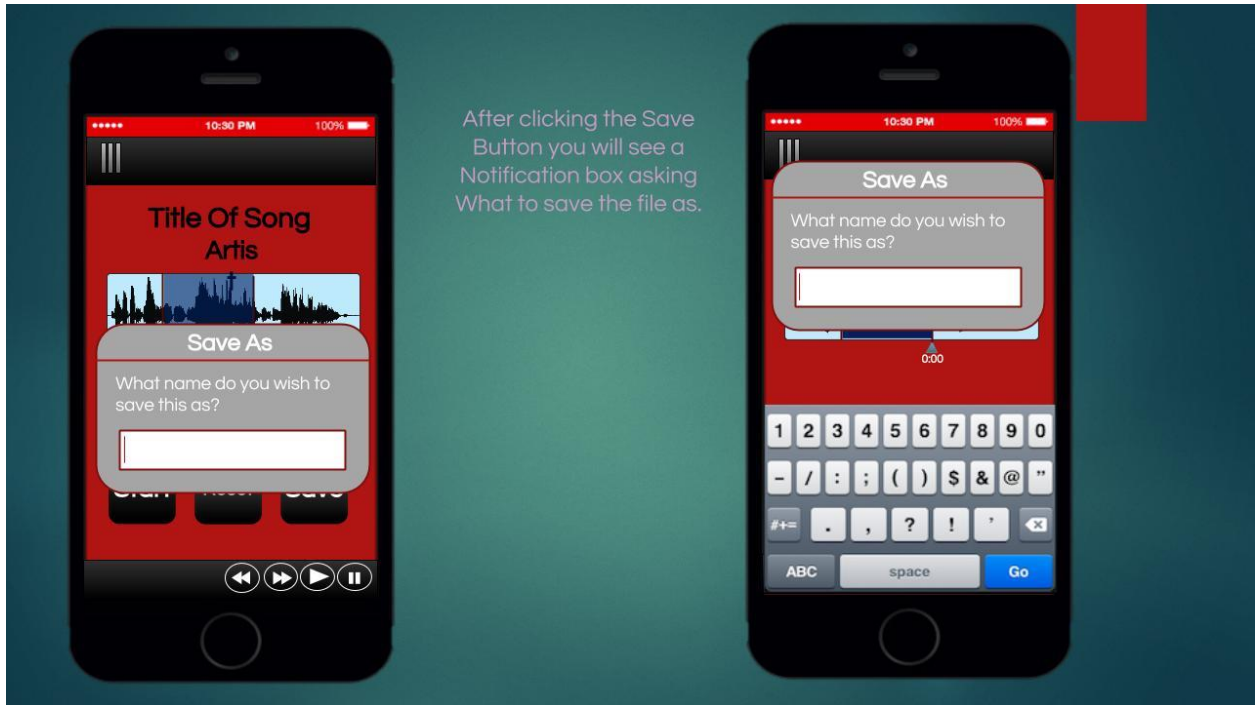


Figure 6.2: The navigation of saving a selected loop of a song.

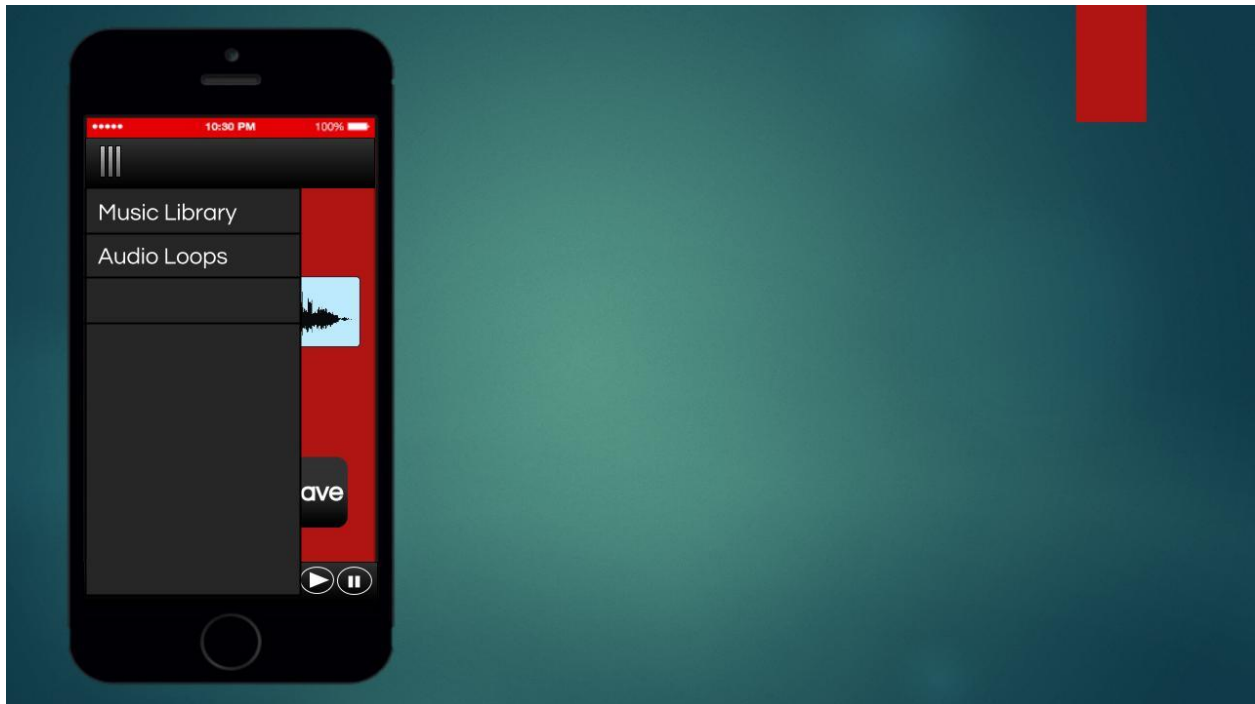


Figure 6.3: An example of how the list of applications can be presented to the user.

APPENDIX B – TRANSCRIBED FOCUS GROUP #1

Codes (Some underlined within transcript and others bracketed { }) generated on Focus Group 1 transcribed meeting for Grounded Theory Analysis.

Focus Group Meeting Transcribed

1. What do you rehearse with?

Ans: Stands, chairs, instruments, bells, rattles, drums {Physical instruments/ known instruments}

2. Where do you rehearse?

Ans: When on campus in Alden. When at home, individually. Instrument sections rehearsing. {Alden Memorial with instrument/orchestra/band section. At home, alone}

3. Do you rehearse without instrument?

Ans: Vocalize before performance. {Vocally, mentally}
Try to think of it (clarinet fingerings) in my head.

4. Mobile device

Ans: iOS

5. Other things you'll want to have

Ans:

- Humidity gauge (for wind instruments. Corks swell and sounds are wrong. So gauge will help to adjust instrument). {Aid instrument operation. Help enhance instrument output}.

- Thermostat (low temperatures crack vocals). {Knowledge of environmental factors that affect musical performance. In this case weather. Can be others}

- Pitch pipe (vocalists want to hear a pitch before they sing. Eg. If there is no instrument/keyboard nearby to play pitch or key on). {Portable vocal aid}

- A metronome. {Digitizing operation}

- Tempo sensor. Sense tempo am playing at and tell me so I could see if what I'm playing is the same. {Practice aid. Working with musicians}

- A tuner. {Digitizing operation}

- Something that transfer from concert pitch to the pitch of your instrument. Eg, If you are told to play a B flat concert scale, what?? {Instructional operation}

6. How do you envision a music app?

Ans: Easy to use.

- Particularly, the metronome, concert pitch converter and tuner will probably will be the most used. {Digital operations that replace current manual ones}

- Shouldn't have too many things going on on one screen. Can throw you off. {Simplicity}

7. App that works with you or does complicated tasks on its own?
 Ans: An app that you could work with. {Partnership with app. Interactive education not just user reception}
 Doesn't need to be that complicated to do everything. Be that simple and work with you.
 Would probably use it more if it did simpler tasks. {Simplicity emphasized}
8. Do you envision such an app to be something you always use in rehearsal, or a last minute go-to if you were struggling with rehearsals?
 Ans: Will probably use the tuning app a lot. If I was a student conductor, I will probably use the metronome part of it. Use concert pitch, to have that and look that up. {Use of digitized operations}
9. Showed them our app.
 Response: Will use recording bit a lot. Not too complicated. Not a lot going on on one page. Would want to see a main menu.
 A pop up menu. Subgroups. Very general terms. Not too fancy. {Ease of navigation. Simplicity}
10. App appearance?
 Ans: Color scheme should not be that crazy.
 Usually do not trust those kinds of apps. Don't want to pay anything for it.
 Try a one letter name app. Eg. Facebook, twitter. {Straightforward name}
 If it had a music related name, may be easier for people to search. Can use a name that has music in it. Can have an icon, that has an "M" in it. {Name should have association with music}
 One "word" icon. Not that People recognize a specific thing but they recognize that kind of style.
 Can use neutral colors. Not super colorful like a gaming app. {Moderate color scheme}
11. What do you think of connectivity and sharing?
 Ans: I see that with recordings. Probably would not (not sure if they said would send) send a metronome to someone.
 Case by case basis.
 Send a section to someone else is a high choice for sharing {Connectivity}
12. Ques from group. Will it connect to your library or will there be a bank of songs? {Content source}
 Ans from us: Connect to your music library so you can access your own songs. Not sure if you will save to your library or just on the app. {Storage issues}
 Response from group: Should also connect to your voice memos (especially for the singers out there) {source of content}
13. Suggestions from group – You can also add the sharing feature to your menu.
 A feature to share with other app users.
Can have groups you can share with, if you were part of many other groups. Something like

sound cloud. Connecting to the systems people already use to share. Eg. Sound cloud, facebook (people like to record their voice and share on facebook. Or they may even have a group on facebook they want to share to) {Social effect of connectivity to other apps}

14. Cost?

Ans: Max amount, 99cents. If really sophisticated, a \$1.99. An average priced app. {Average price}

15. Will you feel comfortable using such an app if you graduated and became a professional musician? Do you feel, you will outgrow the app as you improve in your abilities?

Ans: Yeah! If it was sophisticated. Depends on how many other apps do the same things, and is better, and cheaper, I may switch. {Uniqueness. Cost and functionality}.

16. As long you were doing something different I would use it. {Unique}

Also, will probably be using the concert pitch converter. {Digitized instructor may be used}
The easier it was to use, I would use it. (I hate technology). (This may be true for others who may not be technology savvy).

APPENDIX C – TRANSCRIBED DATA AND IMAGES FROM FOCUS GROUP #2

Codes are both underlined and bracketed. The symbol, >>, indicate a response from a different participant.

Q: What do you rehearse with?

>> Cuz I really mostly play drums, um even if like when I am on a drumset like a metronome app definitely will help. {Digitized Operation}

>> So there are probably are metronome apps.

>> Right Exactly. With that whole app just has everything.

>> So if follows along with you and it has like, like you can hear the song and it has a metronome in the background as you're playing. {Practice aid. Working with musician}

>> That would be pretty cool!

>> And a tuner would be the same. {Digitized Operation}

>> But it would be good to have it as one pack. {Comprehensive package}

>> In one whole place. Yea.

Q: How do you believe a mobile application can help in your rehearsals and what features would you like to see?

>> It would be useful because actually, no wait, sometimes it says the the tempo markings I don't really know what they do or means to translate them from spanish or whatever. So like you can automatically translate tempo markings.

>> Do you mean like adagio.

>> Yea. Yea.

>> So if you like have some sort of glossary of terms so you can search for it. That would be good for me.

>> If you can record yourself.

>> Voice memo is good for basic, not for super high quality

Q: Do you practice by yourself or with a group:

>> If you are playing with a group would you want all the audio to be accessed on the cloud?

>> That would be cool. I mean not everybody has a smartphone but so you can have everyone have the same thing. I mean I don't know how that works if you are actually playing.

>> Have comprehensive changes during the song in a time format. Like my conductor always changes bow markings so if there was a way to put at this time change this to blah, blah,blah. On this day we changed measure to blah, blah blah. {Group learning. Platform ubiquity. Track progress of band rehearsals. Timeline}

Q: Where would you want to see this, on your cell phone or laptop? How much would you be willing to pay?

>> Cell phone is most convenient and if it can go on the laptop that would be nice. For the willing to pay, me I don't mind paying a dollar or two on the app but most people will not pay for apps as just a philosophy so it would have to be a free app if you expect anybody to download it. (Laptop. Most universities, cell phone).

>> Another cell phone then a tablet and then to laptop. With a cell phone and tablets can go on my stand while I rehearse {Physical orientation}. A laptop nah, I'd say less preferable. If your app does something that my tuner or metronome can't do such as document my professors. And it does that then I don't have an alternative right their. That is money right their because nothing else can't do it. A feature that I thought would be cool is metronome markings and with a metronome tell if you are off beat or not. That is something that has never been done before and thats why I would pay for it. And the fact that it will all be accessible on my cell phone. So ten bucks maybe if you do all of that. {Uniqueness of app. Novel operations}

>> If something is available on a cell phone, it is available on a tablet.

Explanation of the apps that they designed.

>> I just based it off of the voice memo thing on an iPhone and I don't know I think it looks nice. At the top is a moving recording bar and you can have a metronome going on top of that or I just put like a separate metronome and tuner if you just want a metronome and tuner. And pretty basic. A big play and record button, select song, play music. Pretty straight forward but what makes apps easier to use. {Straightforward operation. Digitizing operations}

{Integrate design already familiar with}

>> Uh I guess with mine I put each of the functionalities across the top of the app. Um more of a way to slide to the bar. I drew that one before we talked about but you can add in if you want to select a place to loop. {Simplicity and easy usability}

{Have functionalities easily accessible and in a known location}

>> Mine is more for an iPad. I made a similar thing with a moving recording bar. Kay so. Um the main pieces tab where you select your sheet music out there. You can have the start metronome {Digitized operation} button which would automatically generate in like the adagio marking and the automatic fundamental note which is read from two flats from that. Um, there is record mp3 and record video if you want to see yourself I don't know be weird. You can pull changes from master {Group effect} which is an idea I went on before. Um, you have the line that moves when the metronome moves. The option for on and off. you play Each measure has a measure number. The screen is zoomable so you can zoom in on lines and autoscroll is based on your metronome. You can also have an mp3 playing along to know how fast to play it. {Audio enablements with practice aid} Above that you have the account tab to where the orchestra has pieces and there is a master copy. Then you have recording and then you have video recording and you have an assessment tab {feedback on practice} where you can share the recording and get feedback from them and you can show the differences between your recording and the actual playlist. {Comparison of what you played and the right thing. Assessment feature}

{Separate everything by tabs}

>> Um so this is a sheet music button, this is if somebody opens a song and they can see frequency components. This is um, kind of music library books. This is opening up all music

people have in their library. This pencil thing is where people can edit their music in their sheet music and yea this is, so this is a clock thing for a metronome. So this is a record thing. And this is what sheet music would look like in the app and you can have an option button here or something.

{Have icons with meaning}

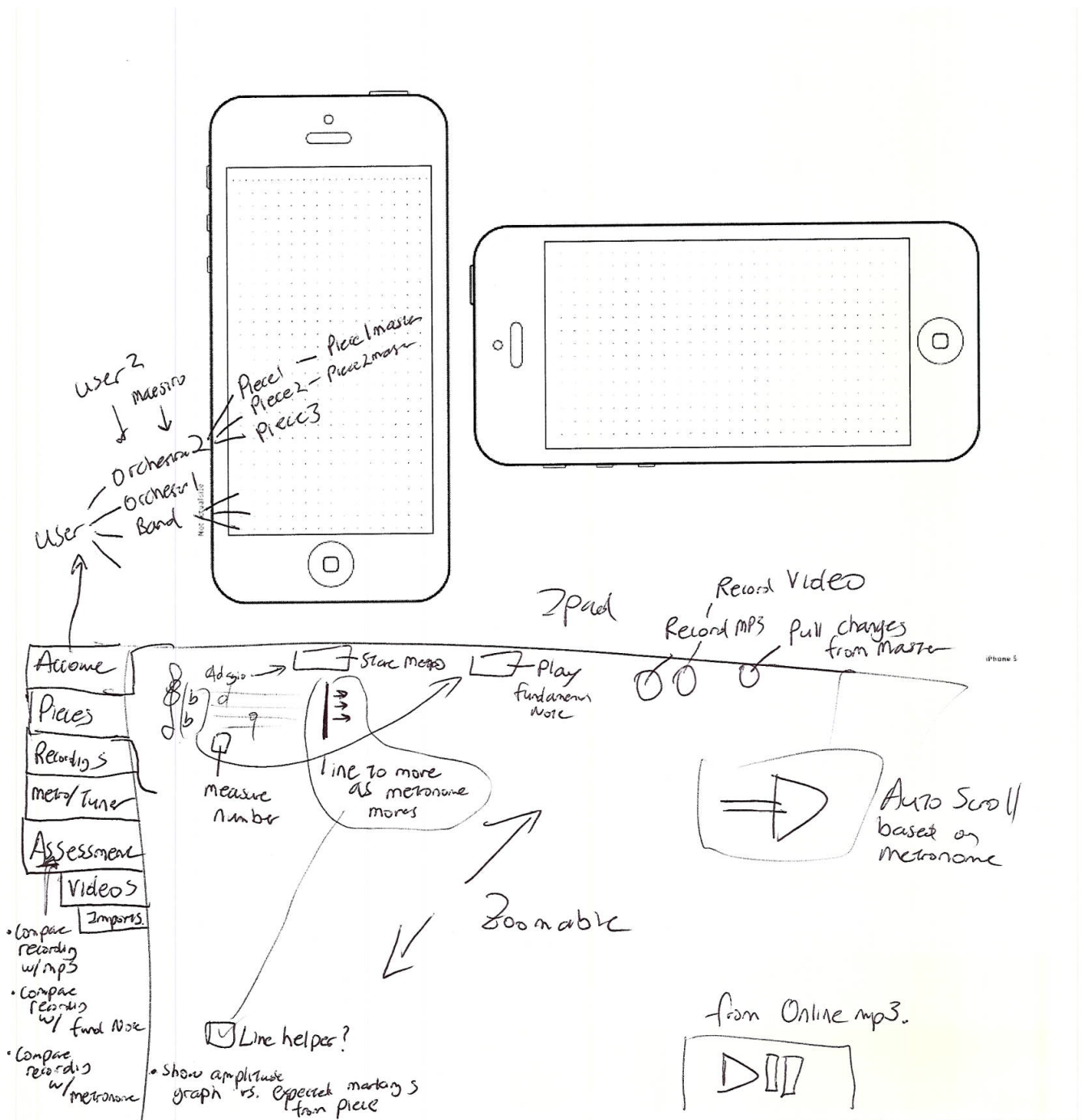


Figure 6. 4 This is n mobile application designed for the iPad from one participant from the focus group.

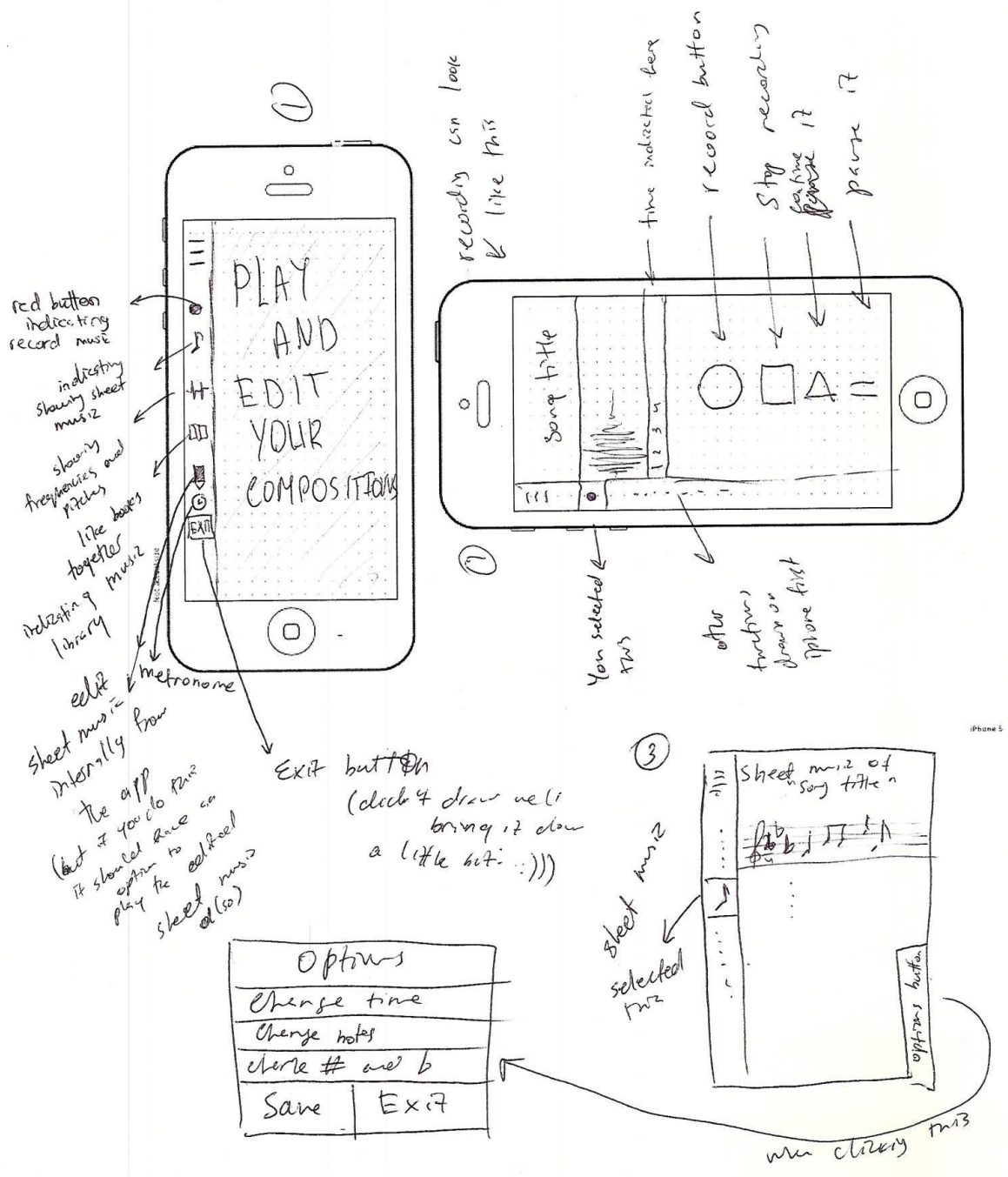


Figure 6.5 Another participant's iPhone app using icons instead of text to have a concise and neat layout.

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