

Usability Testing Overview

Test 1 & 2:

We did first and second usability tests back to back using the paper prototyped revised after the 2 heuristic evaluation rounds. Prototype revisions are shown in the tables below.

Usability Test 1: We conducted our first usability testing with a CSE Master's Student in his early twenties, and he has taken the undergraduate HCI course before. We chose this participant because he fits the profile of one of our stakeholders: Graduate Students, and his work requires a lot of concentration. We conducted the test in a small meeting room in the old CSE building. We chose that environment to conduct our test because we were able to reserve that room for 1 hour, no one would come in and interfere with the test, and there was a large table in the middle of the room for us to arrange our paper prototype and quickly switch out UI components. Two of our team members participated in the test: Boyan acted as the facilitator and computer, Thomas acted as the observer and note taker. The process went quite smoothly.

Usability Test 2: The second usability testing was done with a 20-year-old undergraduate student. We chose this participant because he fits the profile of one of our stakeholders: college students. As a college student in an engineering major, his work requires a lot of concentration. The test was conducted in a study room in the Odegaard Library. We chose that environment because it was accessible to both of us, and a place where we would not be distraction by loud noises or moving people. There was a table that had all of our prototype components laid out that allowed for UI components to be swapped in and out. One member of our team participated in proctoring the test: William acted as both the notetaker and the facilitator.

Protocol: We started off both of the testing sessions by first introducing ourselves and inviting the participants to introduce themselves.. Then, we told the participant that we are going to assign him some tasks to accomplish using our design, he is encouraged to ask questions whenever he wanted, and nothing he does will be considered "wrong" in this session. We encouraged the participant to employ the "Think aloud" method, speaking his mind when taking each step to accomplish tasks. We then went over the problem we are trying to solve with our design, and the overview of the three main components we have: MR headset, MR application, Mobile companion application. We then presented the tasks for him to accomplish:

1. You are currently studying in your room and you feel like the environment is too familiar for you to focus. You would like to feel like you are studying in a library. How would you do that?
2. You are currently studying in a coffee shop. People there are distracting because they are talking and moving around. You would like to feel like you are studying alone in the coffee shop. How would you do that?
3. Let's say you are in a virtual environment with a background of the library, and you are not completely satisfied with some of the settings. How would you change them?

4. You would like to upload a picture you took at the park to be the virtual work environment background, and put yourself in that virtual environment to study or work. How would you do that?

Test 3:

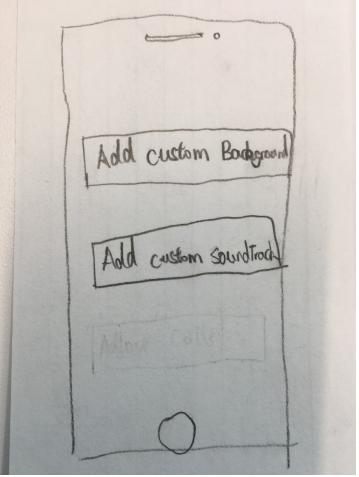
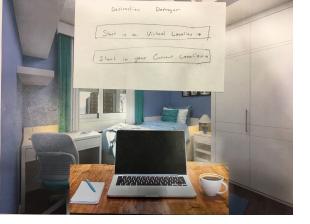
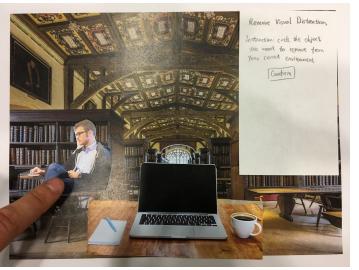
After revising our prototype based on the feedback from the first two usability tests and our self-heuristic evaluation session, we conducted our third usability test. Prototype revisions are shown in the tables below.

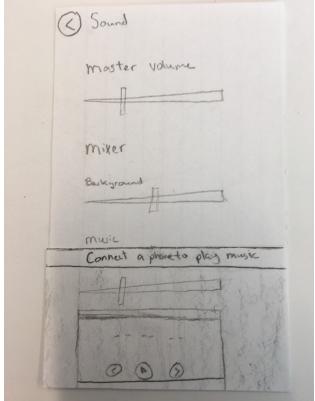
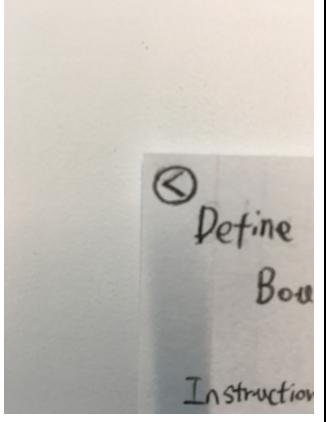
Usability Test 3: The second usability testing was done with a 19 year old undergraduate student who is considering of doing BioChemistry or Math and Pre-Med. We chose this participant because he fits the profile of one of our stakeholders: college students and reasonably tech savvy. The test was conducted in the Gallagher Law Library. We chose that environment because it was close to both where our team members live and where the participant lives. The library was quite and we had a large enough table that had all of our prototype components laid out that allowed for UI components to be swapped in and out. Two members of our team participated in the testing session: Boyan acted as the facilitator and computer, Teran acted as the observer and notetaker.

Protocol: We made some changes to the protocol we used for the first two usability tests. In the previous revisions, we removed the companion mobile application, so Task 4 from the original protocol was also removed for this testing session. In addition to that, we also asked more questions at the final reflection session (after the tasks are finished) about any confusions the participant raised when they “think aloud” when stepping through the tasks. This worked really well because it prompted the participant to further explain why they felt confused in the first place and gave us clearer directions on how to solve those issues.

First Usability Testing Discussion and Revision

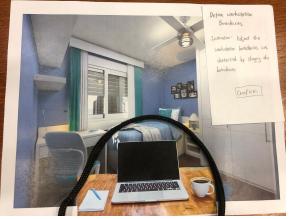
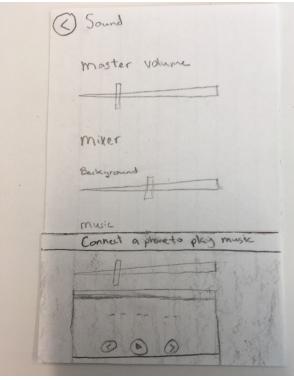
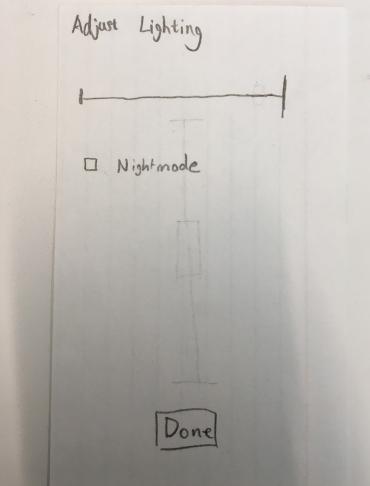
Image	Issue	Severity	Revision / Discussion	Revision Image
	(Task 1) User did not understand what workstation boundaries mean.	4	We will bring in a string to represent the workstation boundary.	
Did not have a Homescreen for MR App. Homescreen for Mobile App:	(General) The system is not showing status that indicates they are in the homescreen, both MR and mobile	2	We added a home menu that the user will see upon starting up the MR or mobile app.	Homescreen for MR App

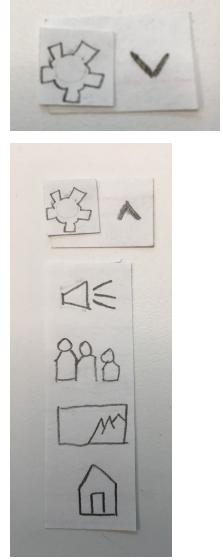
	<p>app</p>	<p>Note: This companion mobile app is eventually removed after our team did self-heuristic evaluation again after the second usability test. See documentation below.</p>	 <p>Homescreen for Mobile App:</p> 
	<p>(Task 1) User did not understand what the “Turn Off” button means in the settings menu.</p>	<p>2</p>	<p>We will change the “Turn off” button in the settings menu to a home button. We will also add a home menu.</p> 
	<p>(Task 2) User was not sure how the interface would show an object is chosen to be removed.</p>	<p>3</p>	<p>Similar to the work boundary issue, we will add strings to represent what distractions the user has chosen to circle</p> 
<p>N/A</p>	<p>(Task 3) Not sure what the default sound is for a custom uploaded background</p>	<p>1</p> <p>Since the custom uploaded background is not curated by the design team, we will not have a default sound for that custom background.</p> <p>Note: This feature,</p>	<p>N/A</p>

			uploading custom background is eventually removed after our team did self-heuristic evaluation again after the second usability test. See documentation below.	
	(Task 3) Not sure if background sound or the soundtrack is louder? It is not clear "Make soundtrack part of the background sound" means	3	To solve this issue we will have a master soundbar to which controls the overall sound level that is outputted, as sound comes from the background sound and music sound. We will then have two more separate sound bars where one consist of the background sound and the other consist of the music sound.	
N/A	(General) More back buttons should be added	2	In each of the settings pop-ups, we will add a back button.	

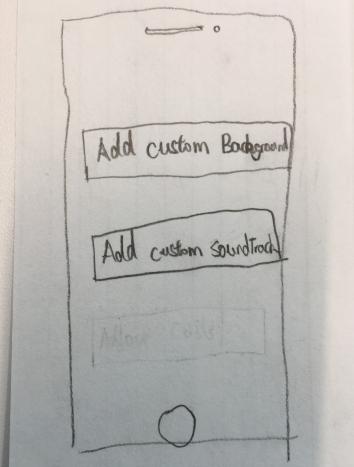
Second Usability Testing Discussion and Revision

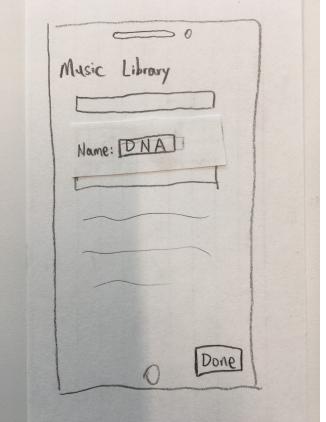
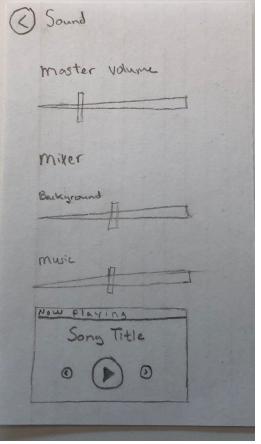
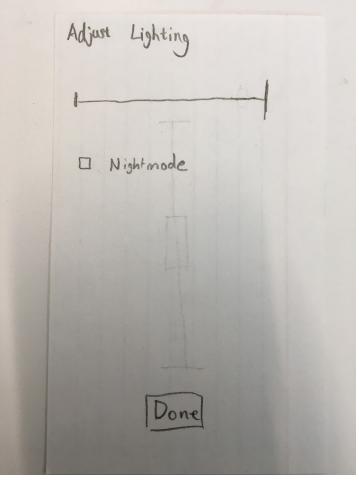
Image	Issue	Severity	Revision / Discussion	Revision Image
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	<p>(Task 1) The user didn't know what the workstation boundaries meant, or how to adjust them</p>	4	<p>We discuss this in the First Usability Testing results</p>	
	<p>(Task 1) The user wasn't sure if the "sound" bar in the settings menu adjusts. Music? Background sound?</p>	3	<p>To solve this issue we will have a master soundbar to which controls the overall sound level that is outputted, as sound comes from the background sound and music sound. We will then have two more separate sound bars where one consist of the background sound and the other consist of the music sound.</p>	
	<p>(Task 3) The user didn't know what lighting/night mode meant (make your screen warmer like on a computer? Make it night outside? Make your screen brighter/darker?)</p>	2	<p>To solve this issue we are going to remove the "night mode" option in the settings menu. We are also going to take away the brightness setting in the drop down menu, and will instead add buttons on the physical device that control screen brightness.</p>	

	<p>(Task 3) The user did not know how to minimize the settings bar after it was opened.</p>	<p>2</p>	<p>To solve this issue we will add a down arrow next to the cog so that the settings bar can appear when the down arrow is clicked. To minimize the settings bar the down arrow then becomes an up arrow so that a user can click on it to minimize the settings bar.</p>	
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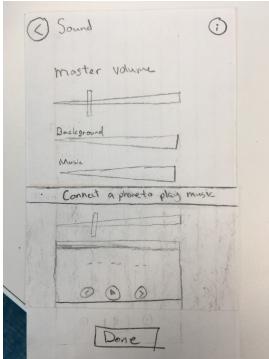
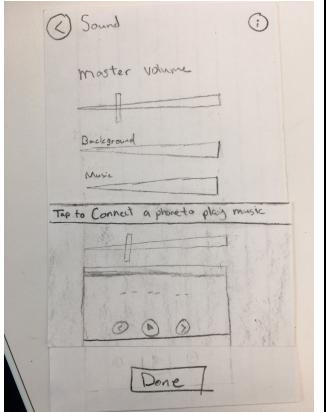
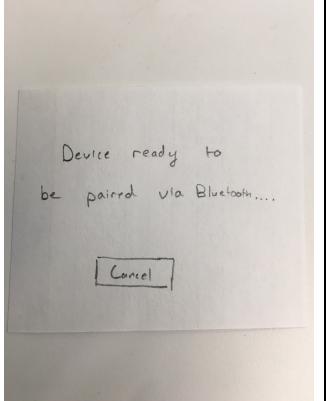
Self-Heuristic Evaluation Discussion and Revision

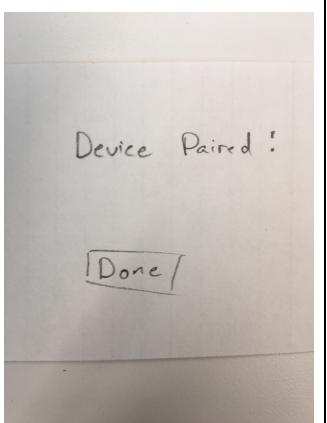
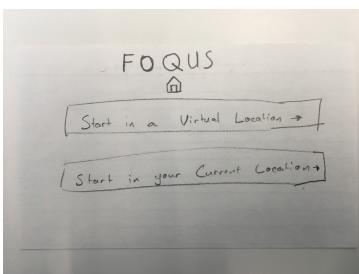
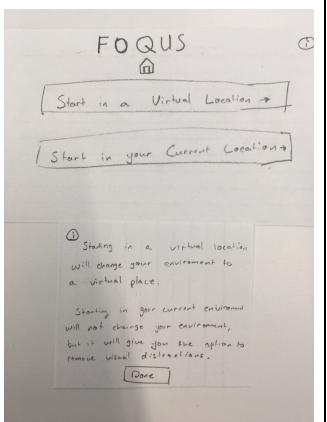
Image	Issue	Severity	Revision / Discussion	Revision Image
	<p>The two features that the mobile app enabled were: 1) allow the user to upload their own custom background 2) allow the user to upload their own custom music. For the first option, the we decided that there wouldn't be a good way to optimize the photos that the user uploads for the device. Also, if we felt that if we gave the user too much freedom, they might get distracted by trying to choose the "optimal" background. The second option is discussed in the row below.</p>	<p>3</p>	<p>After further group discussion, we decided to remove the mobile app from our overall design to make our design more lightweight.</p>	<p>N/A</p>

	<p>We felt that allowing the user to upload their own music made the option of listening to music overly complicated. Nowadays, people stream music from services like Spotify or Apple Music instead of buying or downloading MP3 files. We didn't want to inhibit our user by requiring them to take more steps than necessary.</p>		<p>We decided to add the Bluetooth option and button to connect their phone audio to our device. This way, the user is able to listen to music that already exists on their phone in a way they are already familiar with.</p> 
	<p>We felt that having a brightness setting for natural light was overly complicated, both to implement and to make clear to the user.</p>	1	<p>We decided to remove the option of changing natural lighting. Since now the only brightness setting in the drop-down menu is screen brightness, we decided to remove it from the virtual menu, and add physical buttons for screen brightness.</p> 
N/A	N/A	1	<p>We thought that adding physical sound buttons to adjust volume to the headset would be convenient.</p> 

	<p>Our drawings of low latency cameras did not make it clear for users that we used cameras to create mixed reality.</p>	3	<p>To solve this issue based on Nigini's feedback, we added two cameras on the front and back using 360 camera ability to capture the surrounding environment.</p>	 
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Third Usability Testing Discussion and Revision

Image	Issue	Severity	Revision / Discussion	Revision Image
	<p>The user was not sure how to connect the device to his phone with bluetooth when he has already started using the device.</p>	2	<p>To solve this issue we will have a prompt to connect to the user's phone when the user is already within the mixed reality environment. The user will be able to avoid having to physically press the bluetooth connect button on the headset.</p>	 

				
	The user was unclear what the background button in the settings menu does if they are working in the current location.	3	To solve this issue when the user is in its current environment and is in an augmented reality, we will change the background button to an remove distraction button represented as an eye with a diagonal line across. This allows the users to remove addition distractions while not changing their current background.	
	The user at times did not know what the given option buttons meant, such as what "workstation" meant.	3	To solve this issue we will add a help button on each prompt screen. This help button will be displayed as a question mark, as when clicked it will display a text pop-up to which gives a thorough explanation about the current option buttons.	

④ Remove Visual Distractions

Instruction: circle the object you want to remove from your current environment.

[Confirm]

④ Remove Visual Distractions

Circle the distractions you would like to remove from your current environment. With your finger and press remove. Press done when your environment is distraction free!

[UNDO ⏪] [remove 🗑]

[Done]

⑤ Define workstation boundaries

Instruction: Adjust the workstation boundaries we detected by dragging the boundaries.

[Confirm]

⑤ Define workstation boundaries

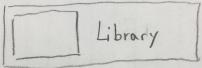
Instruction: Adjust the workstation boundaries we detected by dragging the boundaries.

[Done]

⑥ Your workstation is the area you still want to see while in your virtual environment.

[Done]

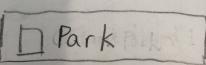
⑥ Select Background



Library

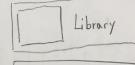


Coffee shop

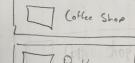


Park

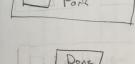
⑦ Select Background



Library



Coffee shop



Park

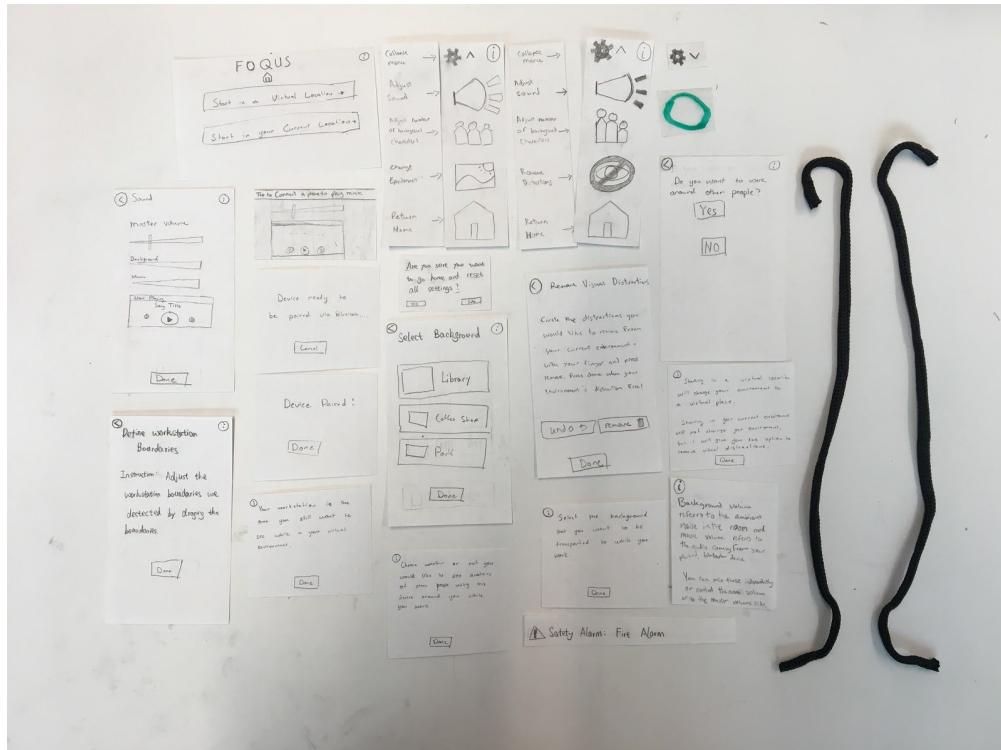
[Done]

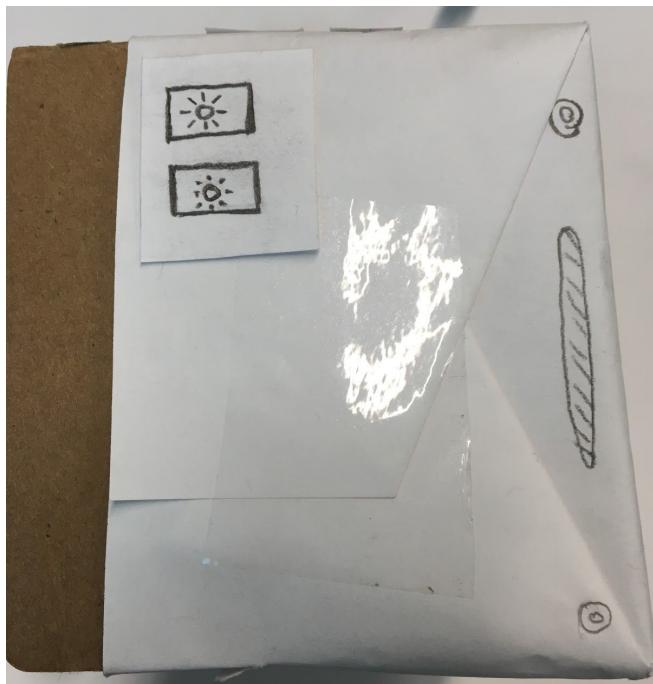
⑧ Select the background that you want to be transported to while you work.

[Done]

<p>② Do you want to work around other people?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p>				<p>④ Do you want to work around other people?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p>① Choose whether or not you would like to see authors of other people using this device around you while you work.</p> <p><input type="checkbox"/> Done</p>
<p>⑤ Remove Visual Distractions</p> <p>Instruction: circle the object you want to remove from your current environment.</p> <p><input type="checkbox"/> Confirm</p>	<p>The user did not exactly understand how to remove people from the screen. The user thought people could be removed one by one with each removal being confirmed by pressing the confirm button. However, we did not allow this capability.</p>	2	<p>To solve this issue we will allow the user to be able to remove people from his viewpoint one by one. An undo, remove, and done button will now be displayed when selecting people to remove. The done button will now be displayed to indicate when a user is completely done with removing people.</p>	<p>⑤ Remove Visual Distractions</p> <p>Circle the distractions you would like to remove from your current environment with your finger and press remove. Press done when your environment is distraction free!</p> <p><input type="checkbox"/> Undo <input type="checkbox"/> Remove <input type="checkbox"/> Done</p>

Updated Paper Prototype Overview:





Updated Task 1 Flow: Make Users Feel Motivated to Work

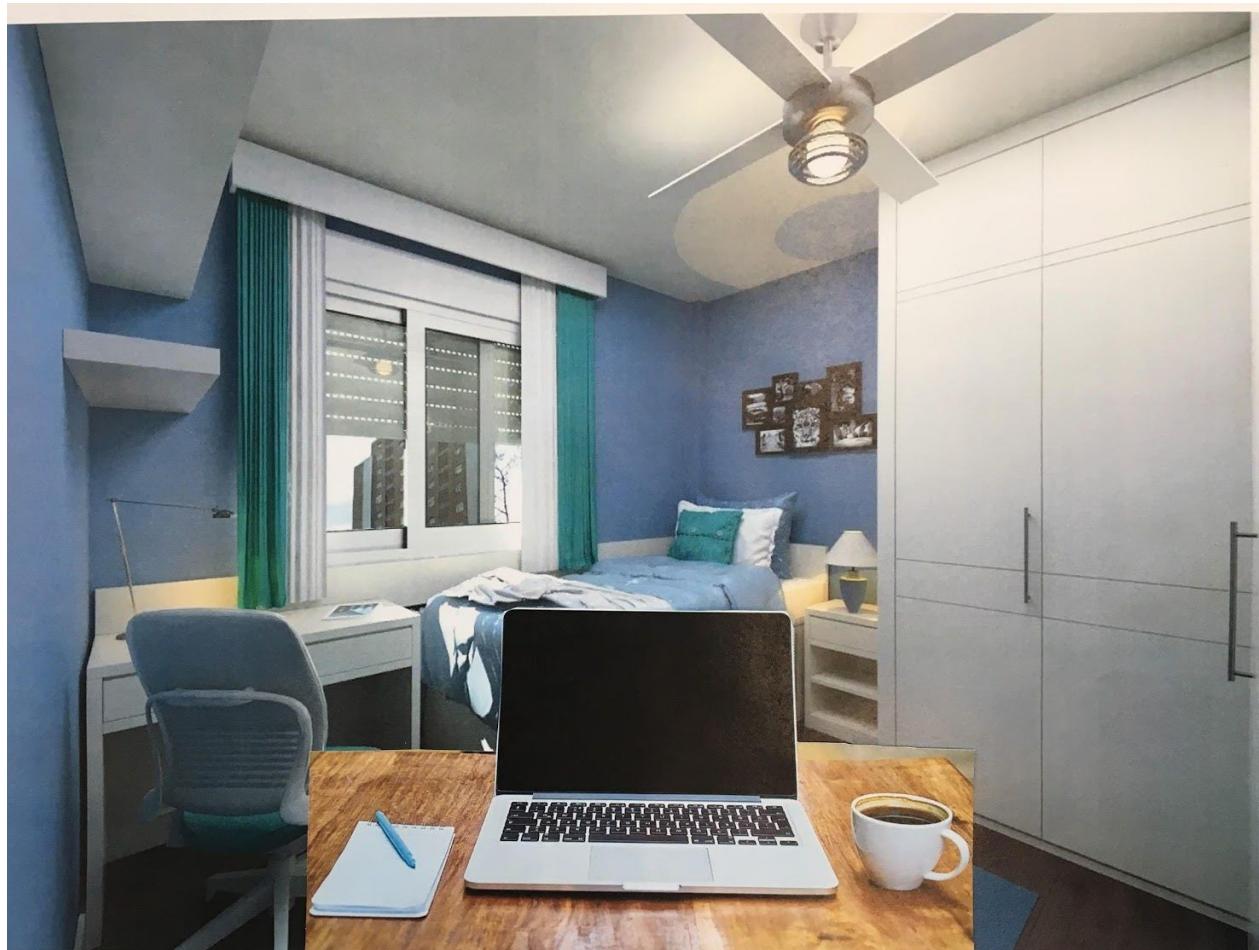


Figure 1.1: The user is studying in their dorm room, and they would prefer to study in a different environment with other people working around them.

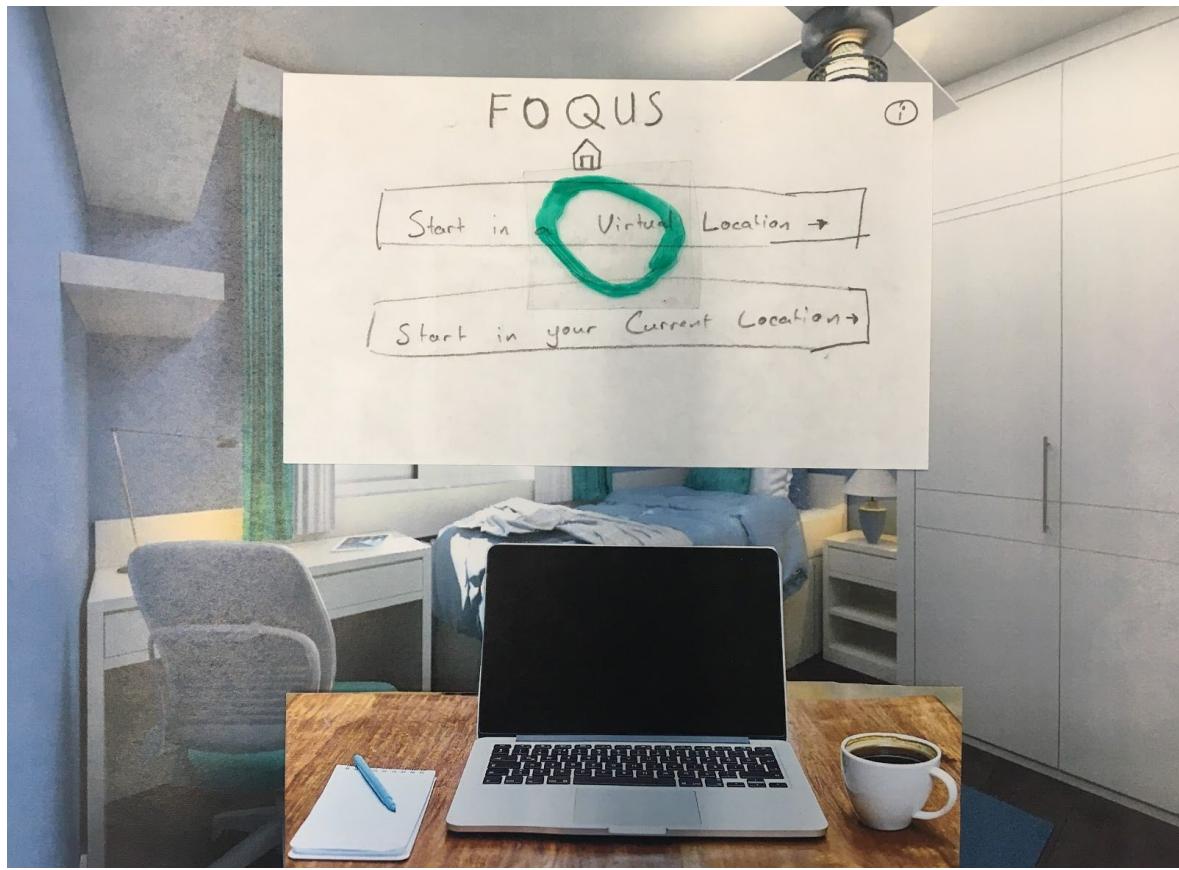


Figure 1.2: The user puts on our MR device and sees the current screen on their MR device. A prompt asks if the user would like to work in a virtual location or if they would like to work in their current location. The user selects “Virtual Location” by clicking on it.

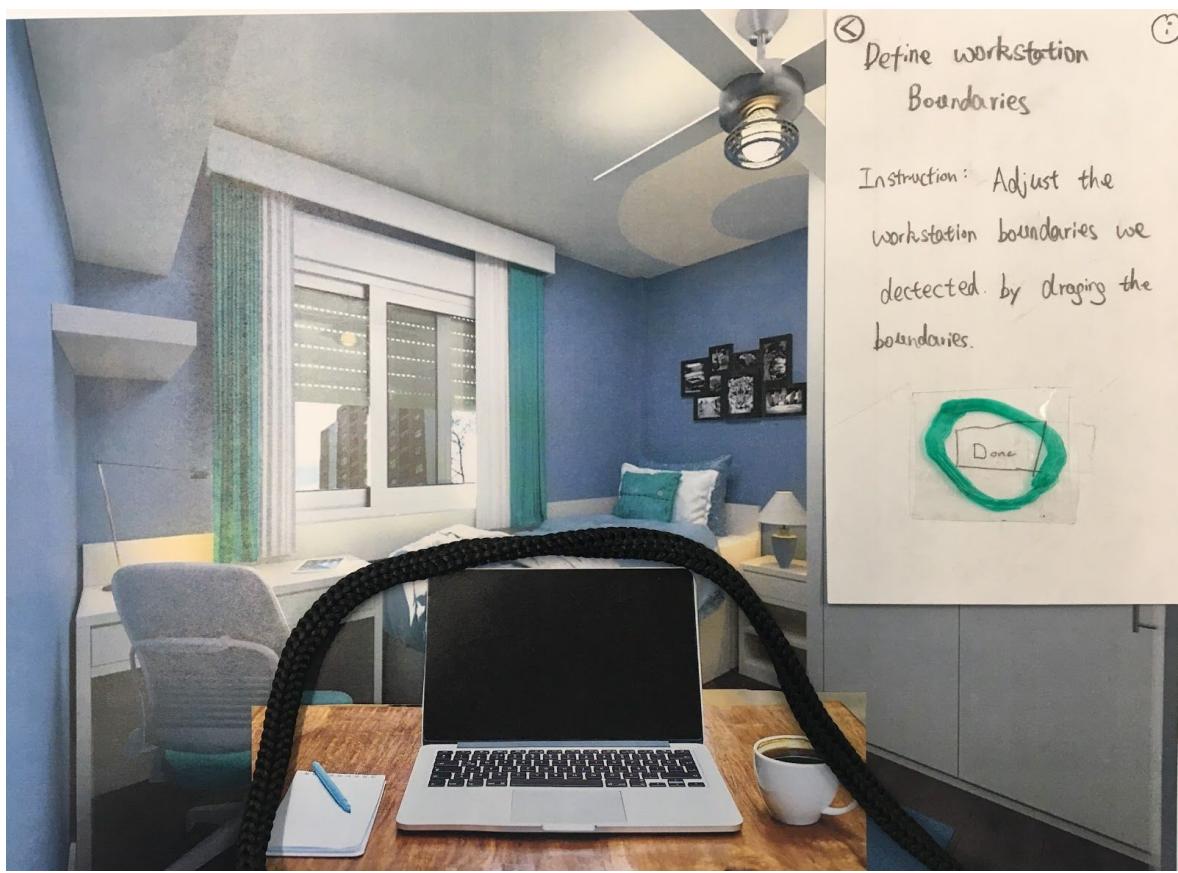


Figure 1.3: The MR application automatically detects the user's workstation boundaries using computer vision algorithms. The user can adjust the boundaries of their defined workstation. In this case, the auto detection was accurate, and the users clicks on “Confirm”.

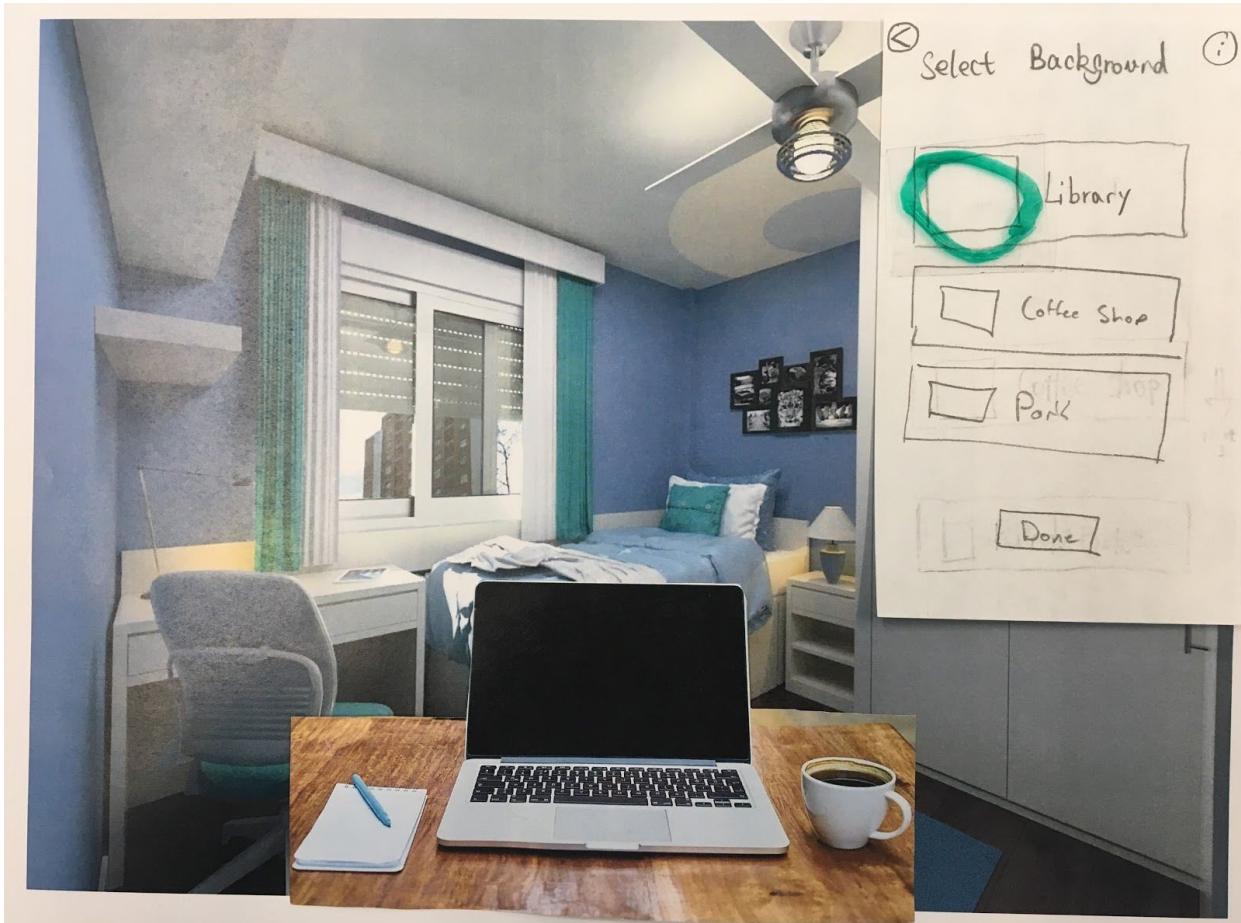


Figure 1.4: The user can now choose select the background for the virtual environment in which they would like to work. Each option has a preview image and a title. The user selects “Library”.



Figure 1.5 :The background is now a library. The user is now prompted to adjust their volume settings. They feel comfortable with the sound around them as it is, and they don't like to listen to music while studying. They click done to move on to the next steps.

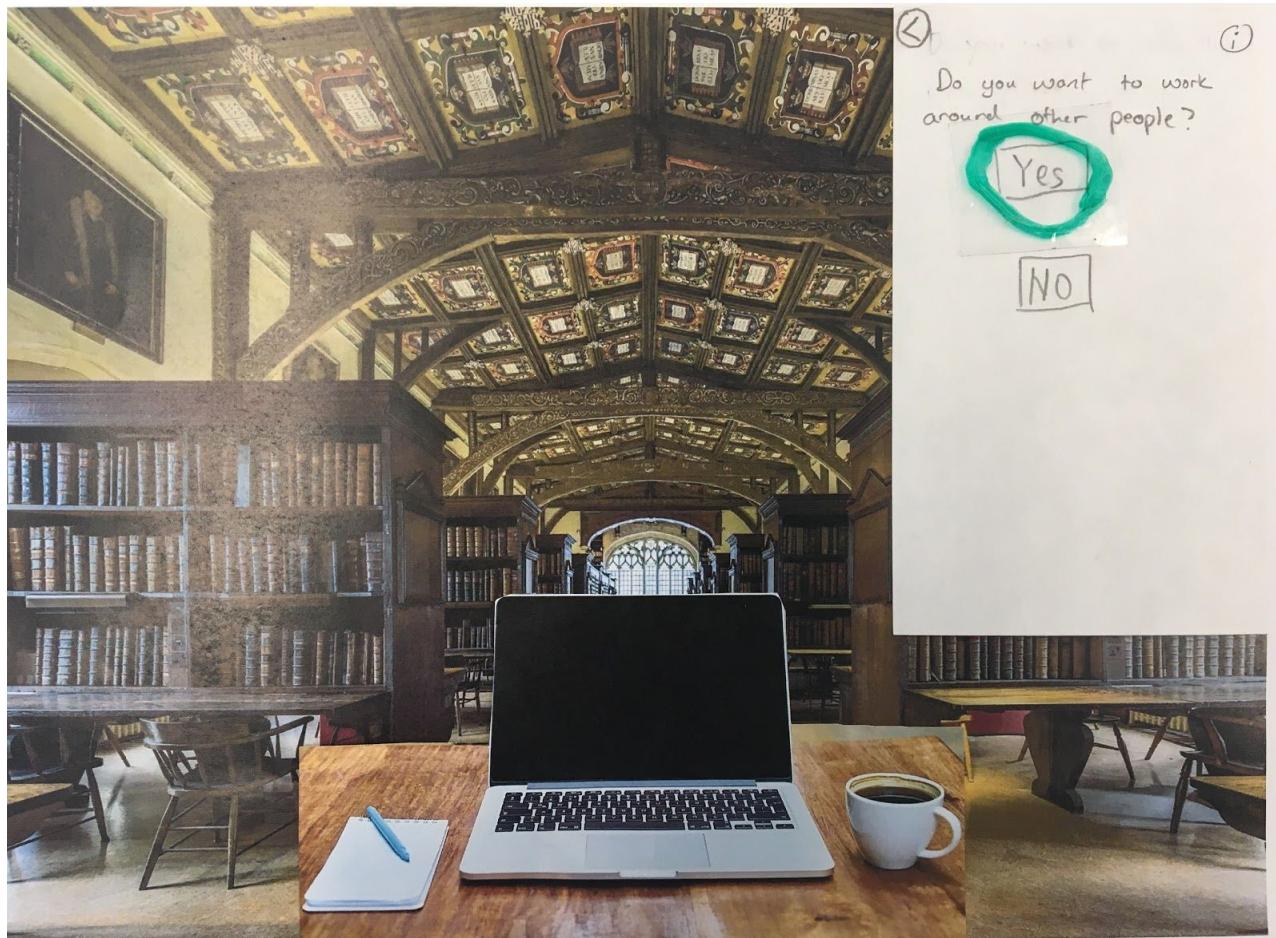


Figure 1.6: The user can then choose whether they would like to work around other people. The user selects “Yes”.

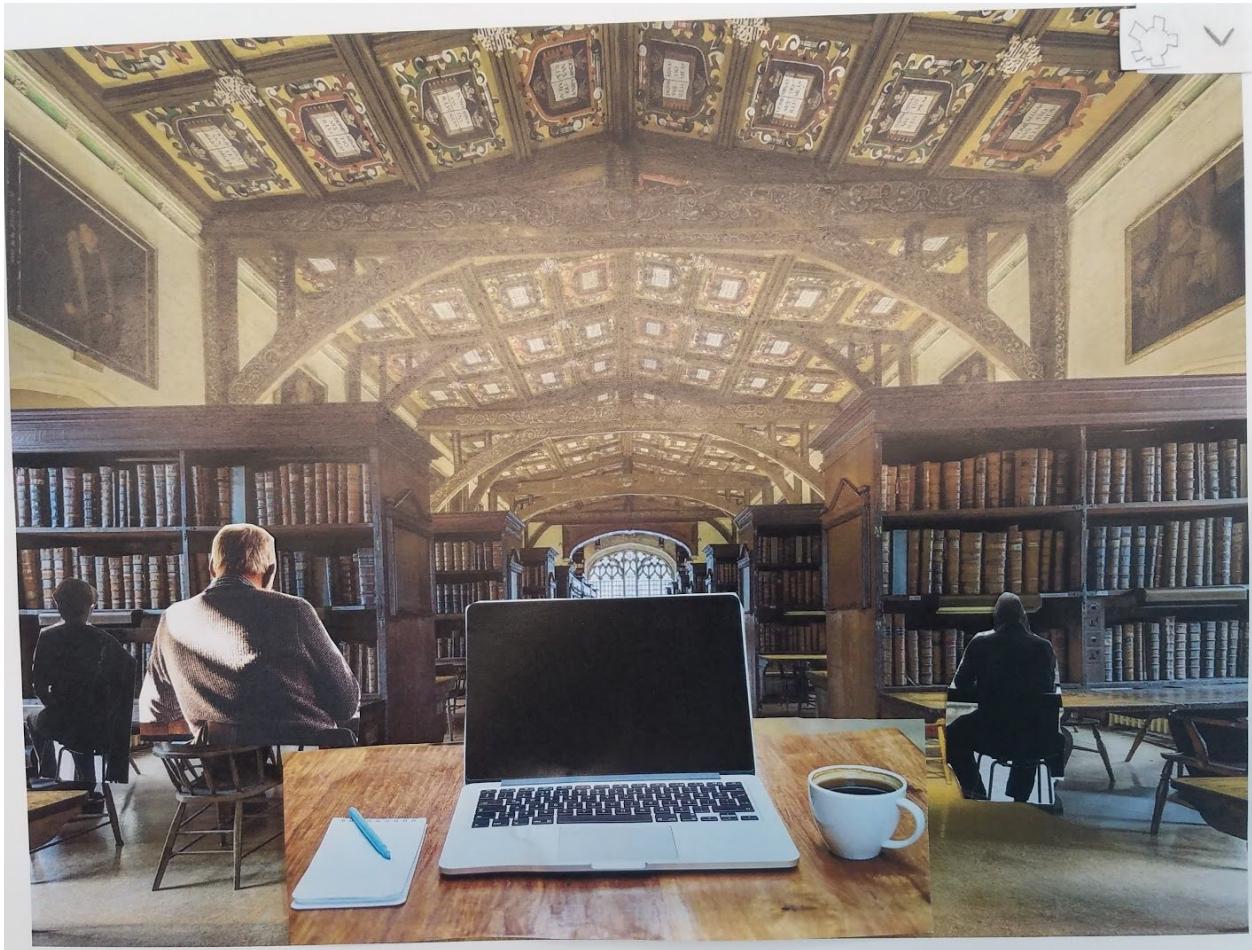


Figure 1.7: Now other users who are also using our design to study or work would appear in the virtual environment the user has chosen. These are real users who are using the system at the moment, however, the system only displays pre-recorded stock videos to represent the kind of work they are doing (typing on computer, reading, writing, etc.). No user information is displayed. The user is now in a virtual library with other people working around them, and they are now motivated to work! Task 1 accomplished.

Updated Task 2 Flow: Remove Distractions



Figure 2.1: The user is studying in a coffee shop where several patrons are having loud conversations and are continuously getting up and moving around. The user is having a difficult time focusing with these surrounding distractions.

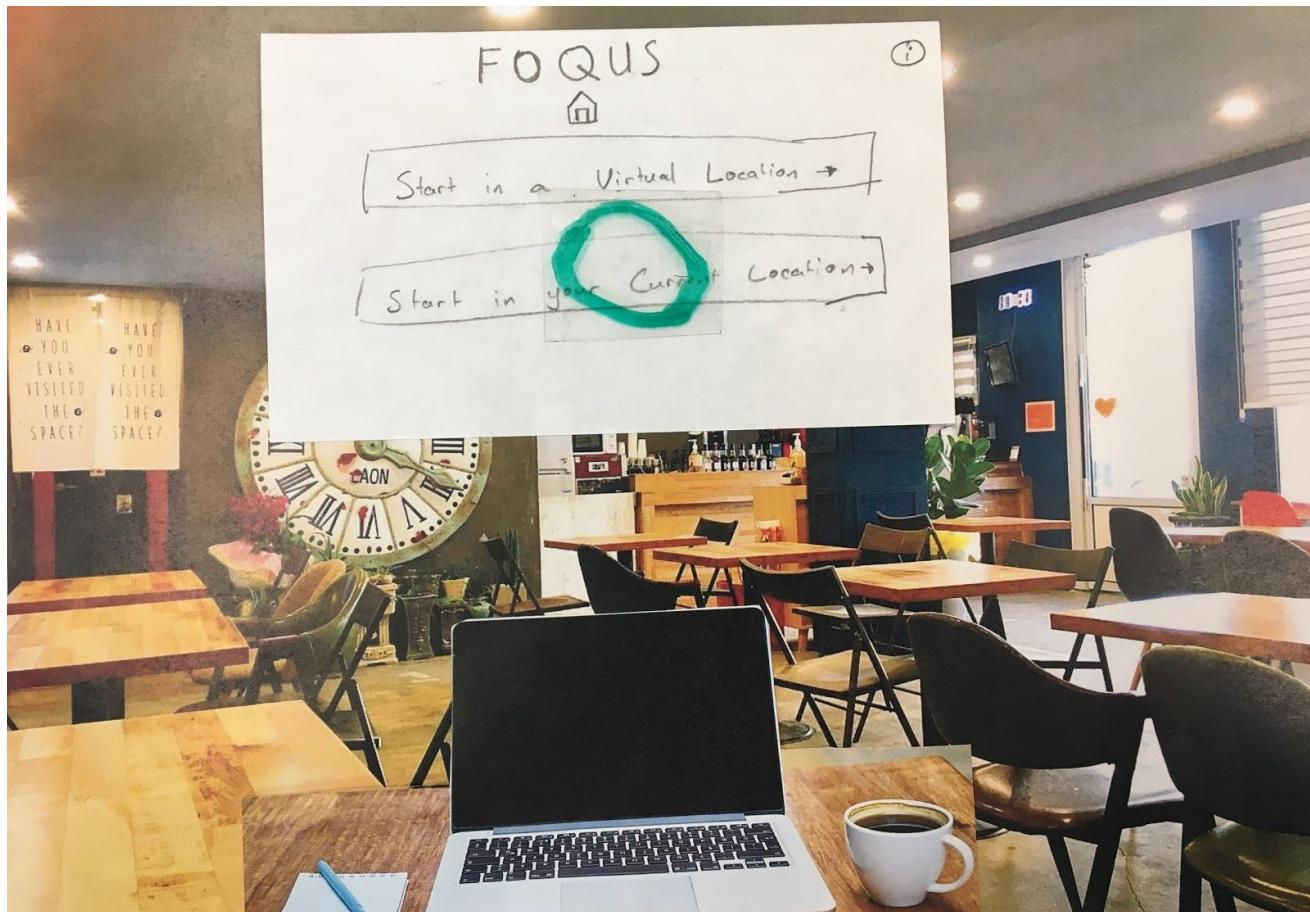


Figure 2.2: The user puts on our MR device and sees the current screen on their MR device. A prompt asks if the user would like to work in a virtual location or if they would like to work in their current location. The user selects “Start in your Current Location” by clicking on it.



Figure 2.3: The user is prompted to circle any visual distractions they would like removed from their view. The user circles the people they would like removed with their finger, and then clicks “Remove”.

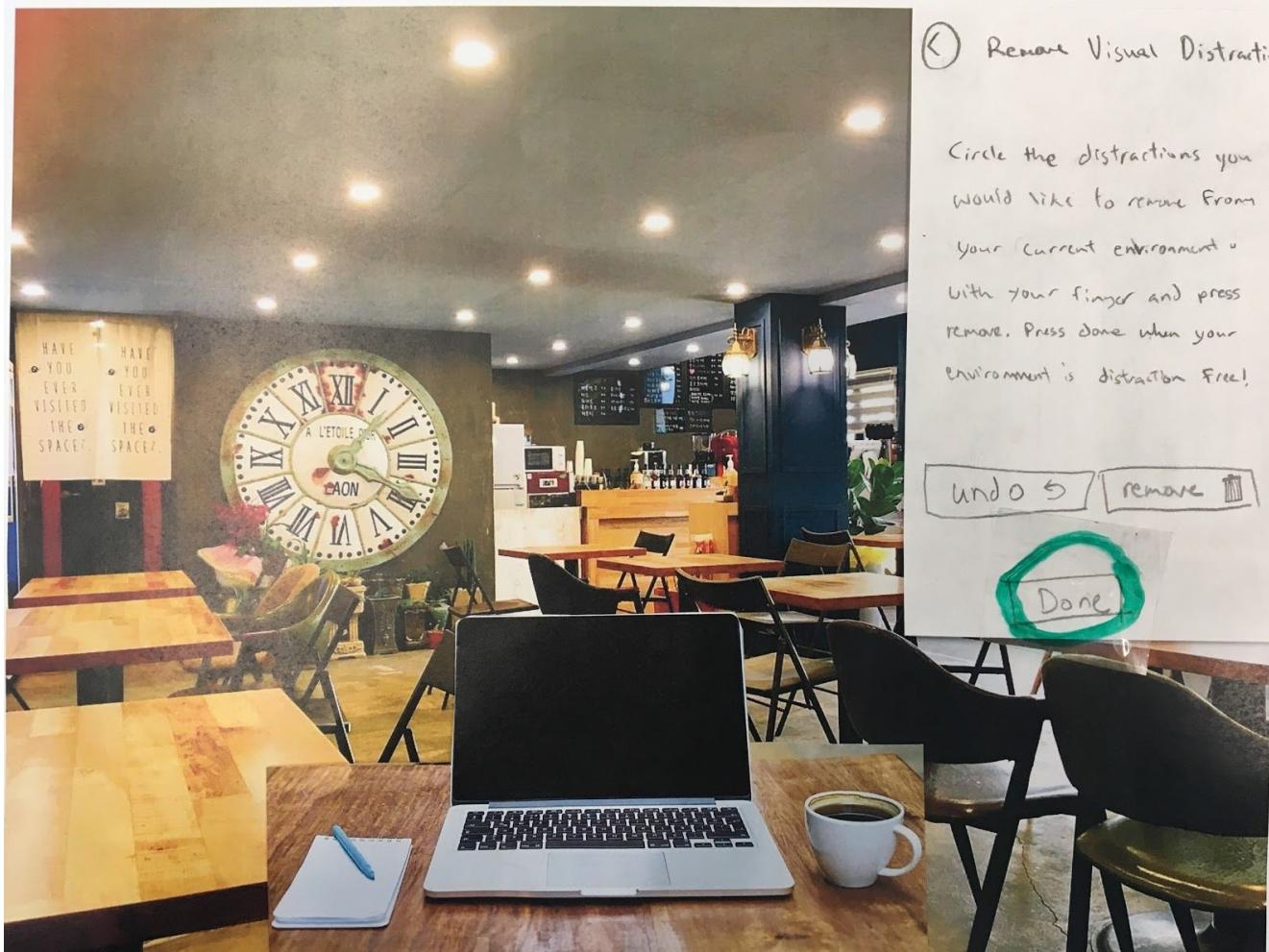


Figure 2.4: Once the user is satisfied that their environment is distraction free, the user can press the “Done” button to move on.

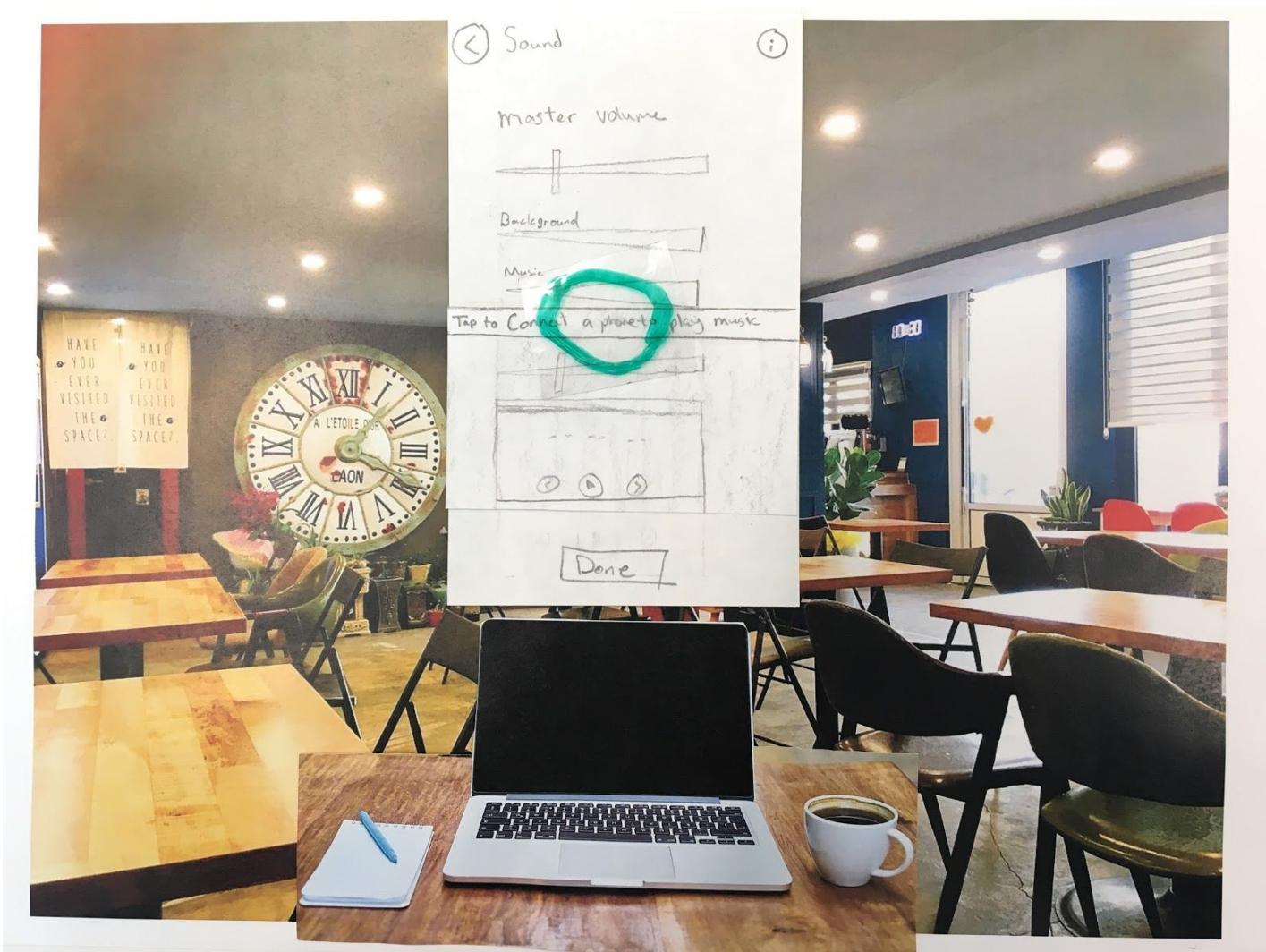


Figure 2.5: The user taps the 'Connect a phone' section in order to pair with their phone via bluetooth. This action puts the phone in pairing mode. The user could alternatively press the physical bluetooth button on the device.

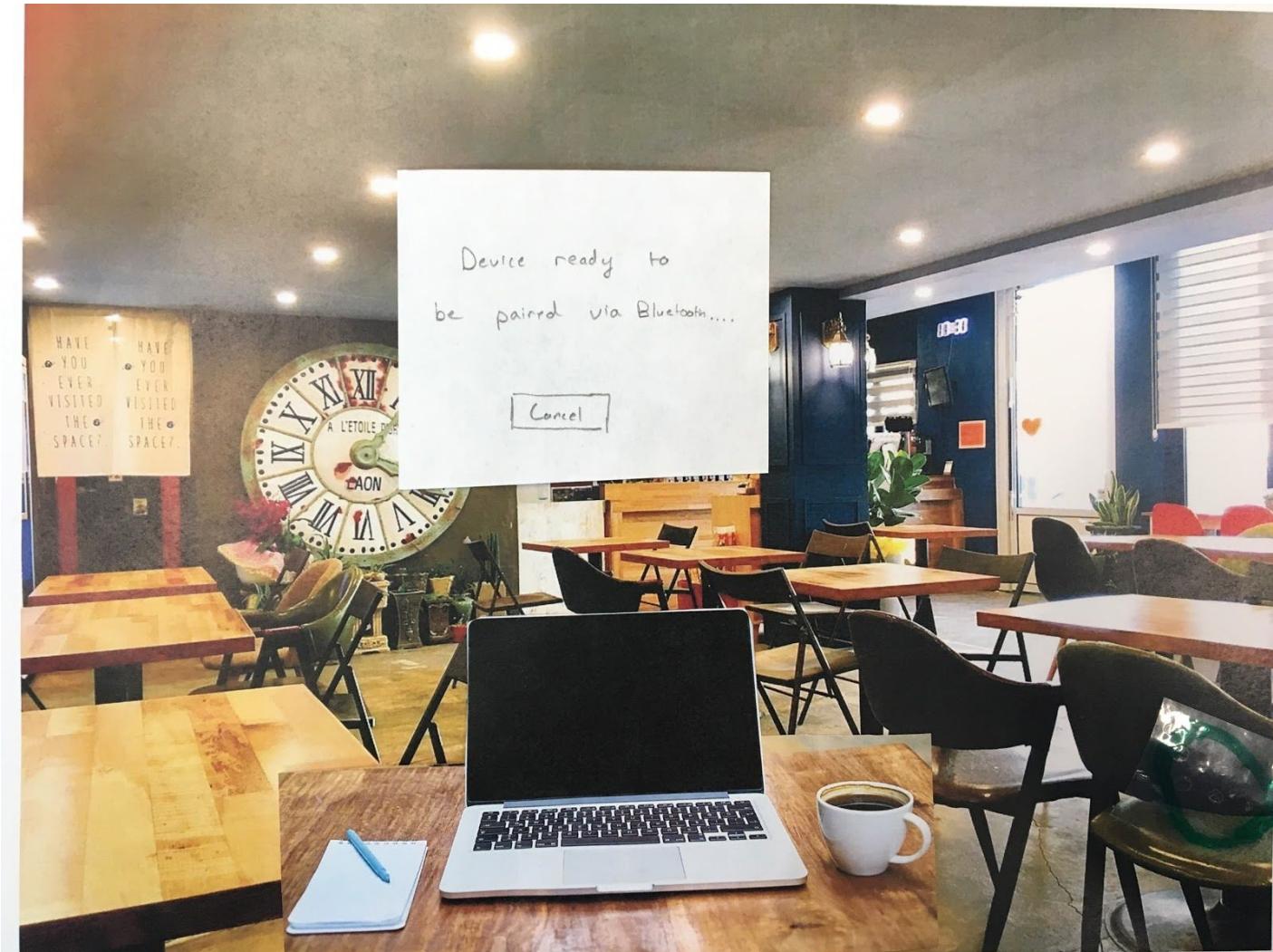


Figure 2.6: The user is prompted to use their phone to pair the device.

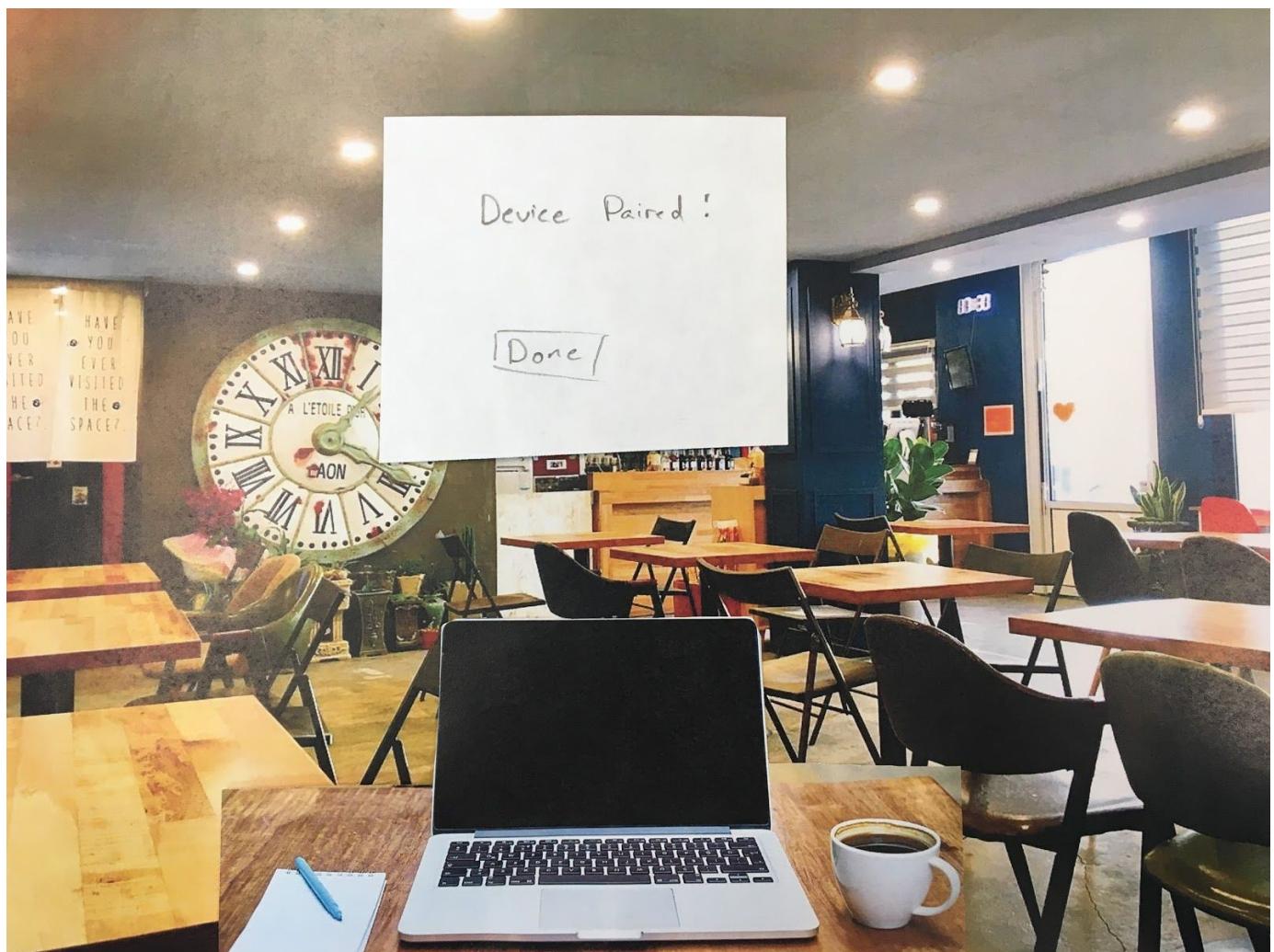


Figure 2.7: Once the device is paired a success message is displayed which the user can dismiss via the done button.

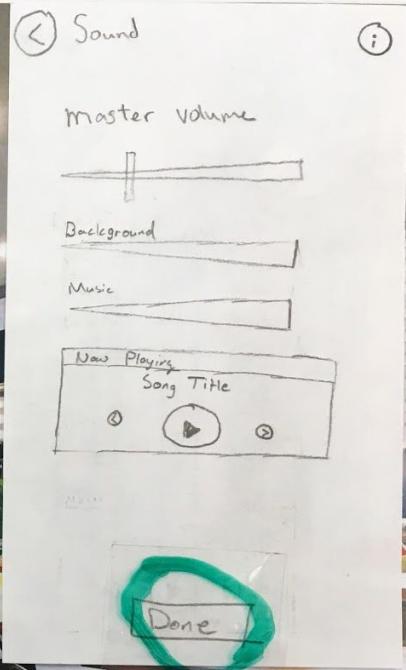


Figure 2.8: The user can move to the next step once satisfied with the sound settings.



Figure 2.9: The user has removed the distractions around them, and is now ready to study! Task 2 is completed.

Most Salient and Important Modifications

Modification 1: (Test 3) Added info buttons and popups. We believe adding the info buttons and popups was really important for the user to understand the prompts and different icons we have in the UI. For instance, it is not clear to some users what a “workstation” means. With the newly added info popups, users can understand that they workstation is the area they still want to see in the virtual environment. This makes our interface a lot more readable and it allows additional help information to be hidden by default so users are not overwhelmed by all the texts.

Modification 2: (Test 1) Added back buttons. We believe adding the back buttons significantly increased our design usability. It allows users to go back to previous states if they want to make changes or when they want to access other things from the previous menu. The effectiveness of these back buttons were shown in our third usability testing session when the participant made

a mistake and immediately clicked on the back button to go back to the previous menu. This makes the task flows more streamline.

Modification 3: (Test 1) Added boundaries to selections. We believe that by adding boundaries when a user attempts to establish their workstation boundaries this would allow the user to clearly indicate what will be their boundaries. A string will be used to allow the user define their workstation boundaries. This is important for our design because we strive to remove distractions around the user, as this can be done by making workstation boundaries more identifiable.

Modification 4: (Self-Heuristic Evaluation) Removed companion app.

We believe that by removing the companion app to which goes along with our headset, we made our device more light weight and easier to use. We wanted to make this modification because we thought we added unnecessary aspects to our design by having a companion app to which allows a user to upload their own custom music and custom background. We decided that there wouldn't be a good way to optimize the photos that the user uploads for the device. Also, we felt that if we gave the user too much freedom, they might get distracted by trying to choose the "optimal" background. We also felt that allowing the user to upload their own music made the option of listening to music overly complicated. Nowadays, people stream music from services like Apple Music or Spotify instead of buying or downloading MP3 files. We didn't want to inhibit our user by requiring them to take more steps than needed.

Credits

Coffee Shop Photo Credit:

<https://www.maxpixel.net/Cafe-Coffee-Jebudo-The-Coffee-Shop-Indoor-2081857>

Library Photo Credit: "Photo by DAVID ILIFF. License: CC-BY-SA 3.0"

URL of the license: <https://creativecommons.org/licenses/by-sa/3.0/us/>

All other images are CC0 Public Domain