

3F: Final Report

QuaLights

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Problem and Solution Overview

The average American spends a lot of time in their homes. According to the Environment Protection Agency, on average Americans spend 87% of their time indoors.¹ That is a lot of time that people may be exposed to indoor air pollutants, yet most are unaware of the air quality of their living spaces. Even if they do have concerns about air quality, people are usually unsure how to act on it. This is a big problem since the air we breathe in can have major effects on our health, especially for those with allergies triggered by air pollutants. Our goal is to educate people about the air quality of their living spaces while also helping them to take action in improving the air quality of their own home in order to foster a healthier living environment using QualLight.

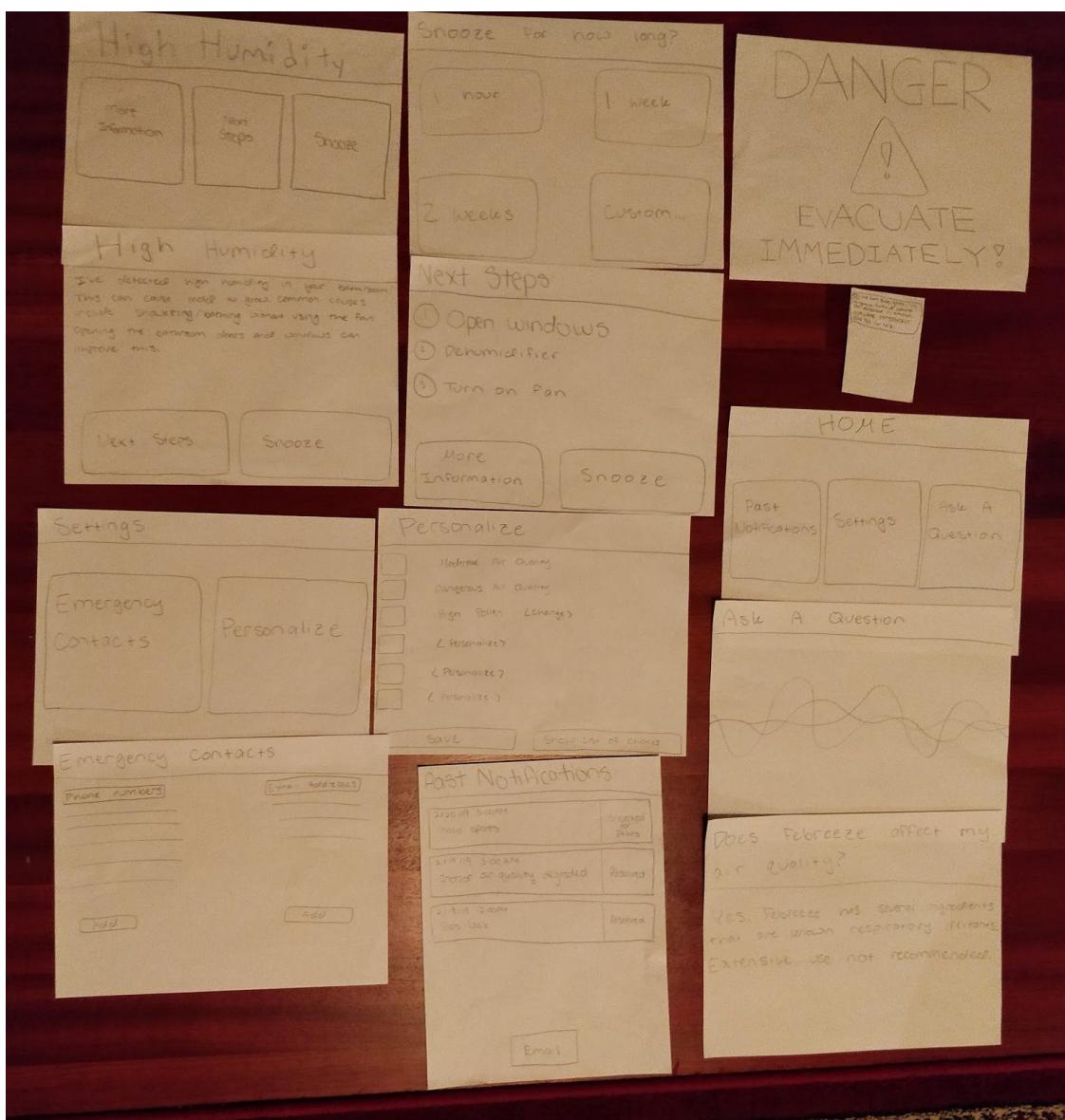
QuaLighst consists of a mobile app, and a physical device. The mobile app helps users to keep track of the air quality status of their home while also being a place where they can go to learn more information about air irritants in general. In order to track their living space, users would place a QuaLights device in any part of their home and we give them the flexibility to be able to hang it on a wall or ceiling, or just place it on a tabletop. The device sends information to the mobile app about the air quality of the room its in, and the light strip around it would light up different colors based on what air irritant it detected so that users can be notified of any changes in air quality even without looking at their phone. Users also have the flexibility to customize which irritants they want to track and be able to turn off the light strip on the device.

¹ Klepeis, Neil E, et al. "The National Human Activity Pattern Survey (NHAPS): a Resource for Assessing Exposure to Environmental Pollutants." Nature News, Nature Publishing Group, 24 July 2001, www.nature.com/articles/7500165.

Initial Paper Prototype

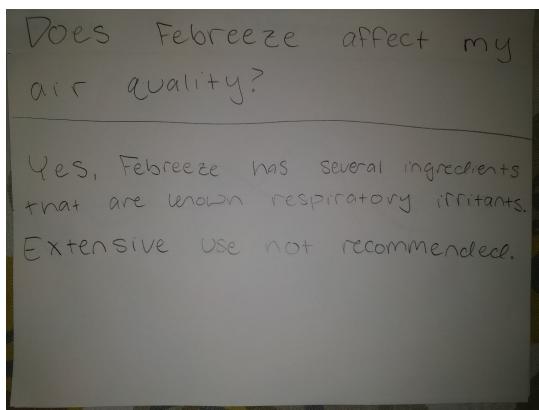
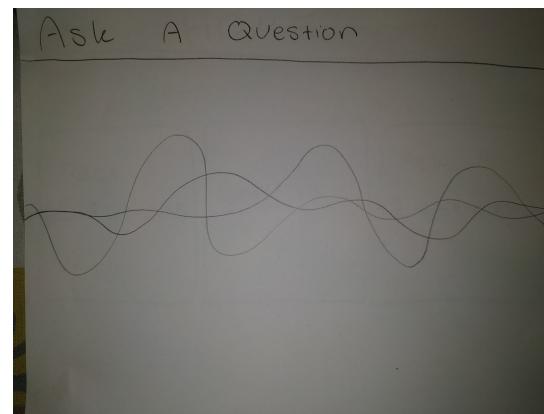
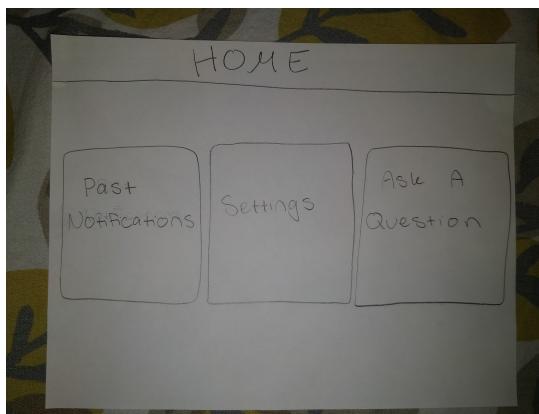
Our initial paper prototype was based on the projection model before we determined through testing that this would create unnecessary complication. The physical device consisted of a box with an illuminating strip of lights around the perimeter with a projector that would display on a wall when placed on an adjacent surface. This interface was controlled by voice and the following screens are the prototype for the interface that would be displayed on the wall by the projector.

Overview Image



Task 1: Educate self about potential air quality hazards

QuaLights allows users to know if certain home products may change air quality within their house. From the home screen, the user can select "Ask A Question", or prompt QuaLights with the phrase "Hey QuaLights". The user then says "Tell me about ", at which point QuaLights provides an auditory response as well as a text display about the affect the product may have on air quality.

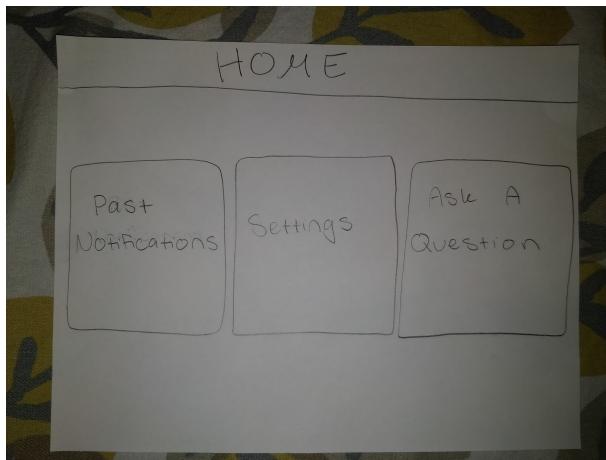


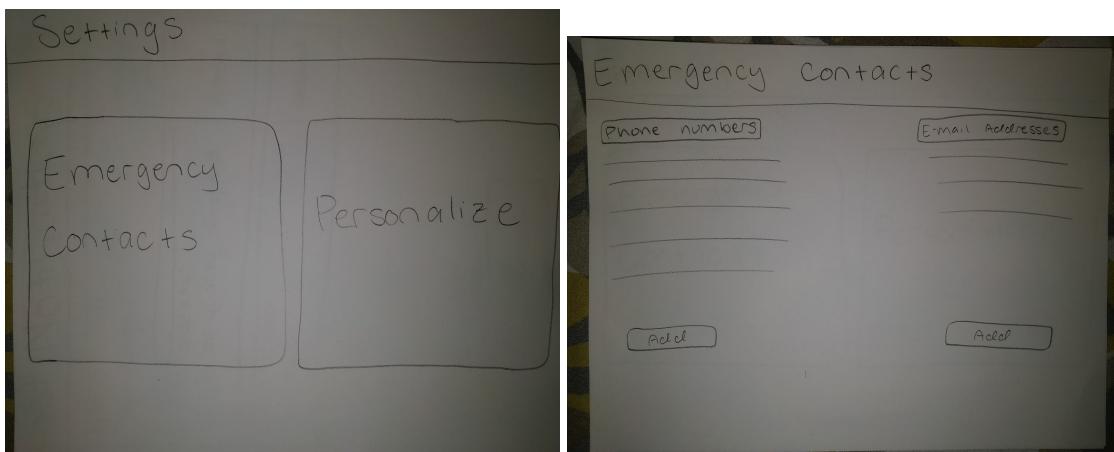
These images show the projection that would be on the ceiling.

These top left picture shows the home screen that would be projected when a user activates QuaLights. The top right picture shows the projection when QuaLights is listening to the user. The bottom left screen shows an example of a question the user can ask and the response QuaLights will give.

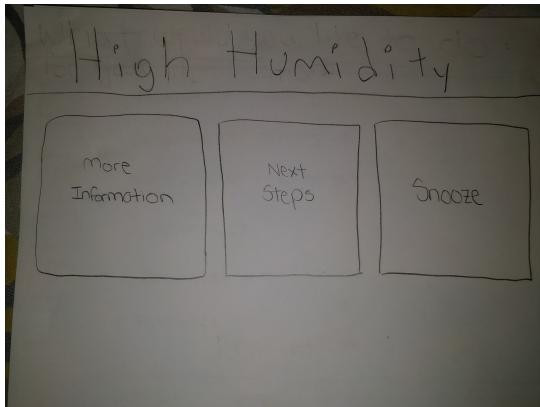
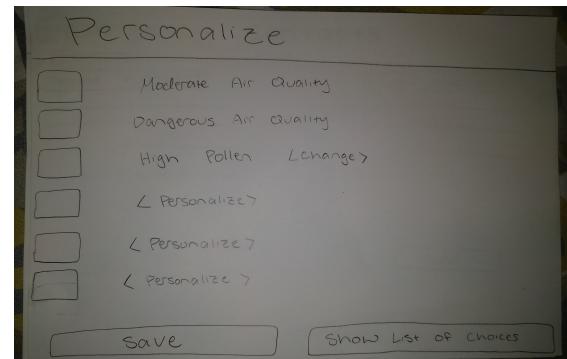
Task 2: Monitor changes in a home's air quality

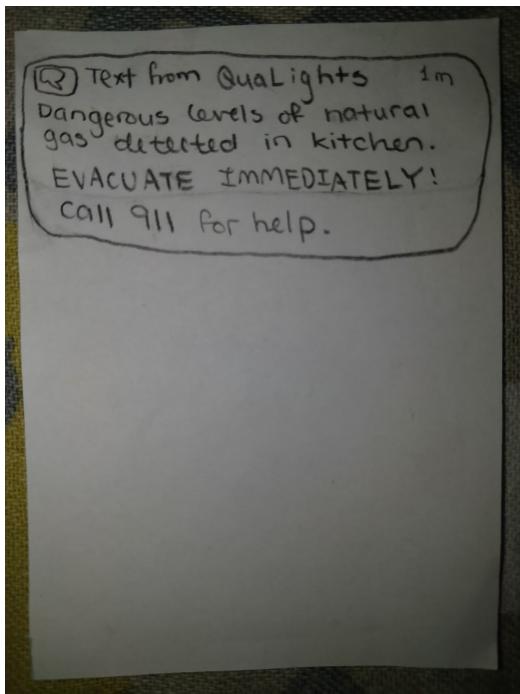
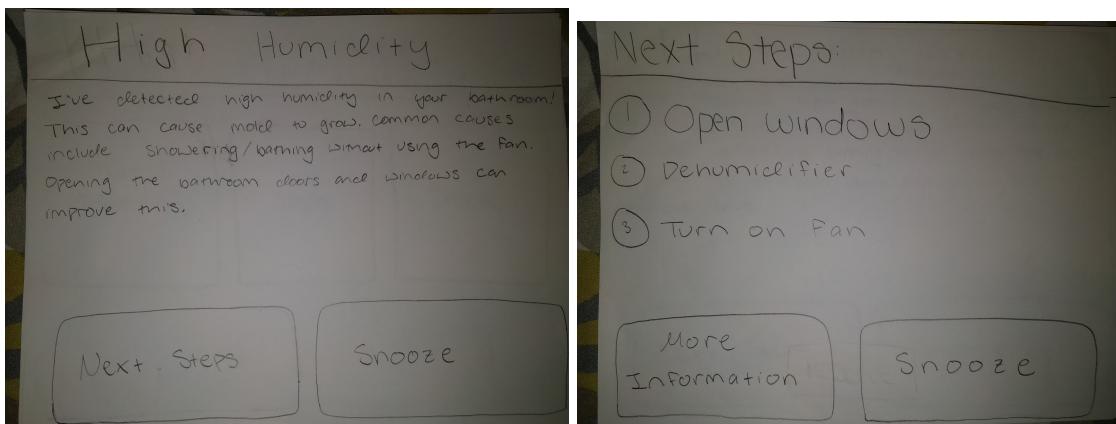
QuaLights allows users to set up personalized notifications for air quality events. Some air quality events have required notifications, while others can be set according to the user's personal preference. From the home screen and using only voice control, the user selects "Settings", then "Personalize", which then allows users to the air quality events they wish to be notified about. Non Emergency events, such as high humidity, will trigger notifications that provide additional information as well as next steps. This is all down using projection from the device.





These images show the projection that would be on the ceiling.





These images show the projection that would be on the ceiling.

Testing Process

Testing Process

In our usability tests, we had at least three of our team members present, and had one person from our team serve as facilitator, one person as notetaker, and one as the "Wizard of Oz". If present, the fourth team member observed and assisted when needed, and contributed to our preparation and debrief. We had scenarios prepared for our two tasks, education, and general air quality monitoring, and we had our participants use our prototyped interface in order to complete these two tasks. The first scenario we had our participants go through was setting up the hardware component of our prototype and synchronizing it with our app, as well as setting their desired notifications for certain irritants. Additionally, we had our participants use our interface to view and respond to a notification about high humidity. We did three usability tests with three different participants, RP, MZ, and KR. Each of our participants was not familiar with our product before the usability test, and did not have a background in science, engineering, or product design. Our participants completed the usability test using our paper prototype of our app.

Reflection

We gained much valuable insight from our participants in not only our design, but also our usability test process. As we completed usability tests, we discovered that it was challenging to clearly communicate with our participants about what they should be doing without telling them exactly what to do. We greatly improved upon this as we completed our usability tests, and we also learned the importance of thoroughly preparing before the usability tests. During the first two tests, we thought that we had all of our screens organized and ready to be presented in the correct order, but during the usability tests we found a few screens out of order and it disrupted our testing. From this, we learned to prepare more thoroughly.

Testing Results

The most important thing that we learned from our heuristic evaluations on our initial prototype was that instead of projection, a phone application would better suit the functionality that we wanted for our prototype. Our heuristic evaluators recognized the difficulty of navigating through a voice controlled interface and found that the projected screens of our device made more sense as a touch interface and would be much easier to navigate as a result. Data entry, which was part of the personalize function of our initial prototype, was also made much easier by moving away from a voice interface. Our heuristic evaluations also revealed our failure to include a lot of necessary navigational functionality, such as returning to previous screens or to the home screen, which we resolved by including those buttons in our app interface. Finally, by transitioning from a projection to a phone app, we had to include screens in our phone application that made it clear to the user how our hardware devices should be connected to the app.

During our first usability test, we continued to run into issues with the voice controlled part of our design. Our participant, once prompted with the second task, forgot what we initially told him about the voice functionality of our hardware device. We realized that we needed to include some reminders or indications within the app of the voice functionality of the device, so we included an information screen during the apps initial setup. We also learned that the 'snooze' function that we had for notifications was placed in a confusing location, so we changed that to the initial notification screen. Finally, we resolved issues with our personalize screen by adding drop-down menus rather than a separate selection screen.

After our first usability test, our designs were critiqued by the TAs in section. We learned that we did not have a strong home screen in our design, since we were operating on the assumption that the first screen the app would open once logging in would be the notifications screen. We added a home screen that was designed similarly to calendar applications to reflect the continuous nature of air quality hazards. Similarly, we redesigned the notification screen to be more aesthetically pleasing, modelling the screen after the weather app on Apple devices. Additionally, we learned that adding emergency contacts was not necessarily a good idea, as it could result unnecessary panic if emergency contacts were notified and the device owner could not be contacted,

for example due to travel. As a result, we removed that screen. Next, we learned that if multiple users were using the app to control QuaLights and change settings, allowing users to set different colors for different air quality hazards could be confusing if one user decided to change those settings. We fixed this by setting each air quality hazard to only one color. Finally, we decided to remove the snooze functionality in favor of the ability to toggle on and off notifications for a certain air quality hazard. Snoozing a notification for a short period of time wasn't really beneficial, and the initial idea behind snooze was to prevent continuous unnecessary notifications during events such as the poor air quality during wildfire season last summer.

Our second usability test resulted in only minor changes. We fixed some internal consistency in the image illustrating device setup and changed the personalize screen again to indicate that additional air quality hazards could be added and that it wasn't necessary to set up notifications for all air quality hazards.

We learned from our third usability test that we should consolidate some of our screens to reduce navigation. For example, our notification screen didn't really need to have a button that brought the user to a next steps screen, but instead could just include next steps in the notification. Additionally, the ability to toggle notifications on and off in a notification screen was confusing, so we moved the toggling ability to a separate screen. This way, users could more clearly see the notifications that they had on or off. Finally, we included more help dialogue for users who wanted additional information on how to navigate the interface.

Before creating our digital mockup, our designed was critiqued one last time by the course staff. We decided to remove voice querying of our device, as it did not add any additional functionality that a quick Google search couldn't provide. We had to find other ways for users to educate themselves about air quality. To do this we added a quick survey users would fill out upon set up so that they can start thinking about their current living situation in terms of air quality. In addition, every month the app will compile all the data it has tracked into a monthly air quality report so that users can monitor the overall air quality of their home over longer periods of time.

Final Paper Prototype

Our final paper prototype differs greatly from the original however the tasks remain the same. The QuaLight device remains the same box with a light strip around the perimeter however there is no longer a projection and the information is conveyed through an app that can be accessed through multiple devices by multiple family members. The voice functionality remains so that the users can ask QuaLights questions about their air quality. During the initial setup the device, settings, and preferences are configured and the main screens in that app communicate information about the homes' air quality.

Overview Image of Final Paper Prototype

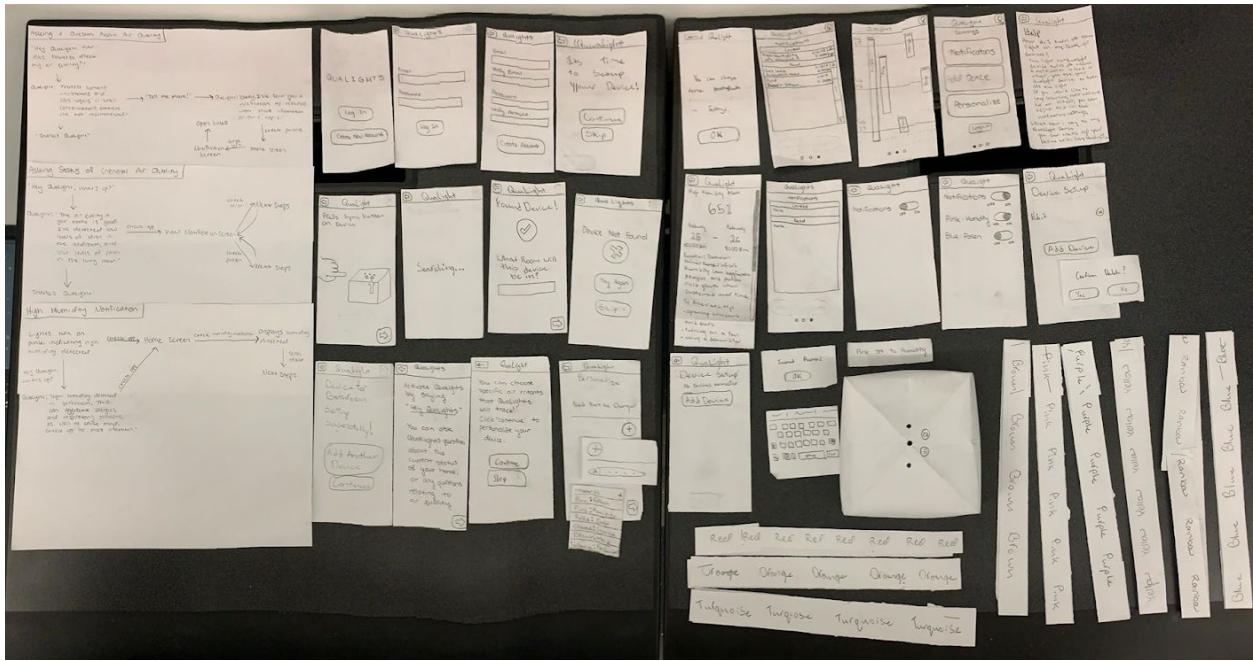


Figure 1. Overview image of all the components of our paper prototype.

Task 1: Educate self about potential air quality hazards

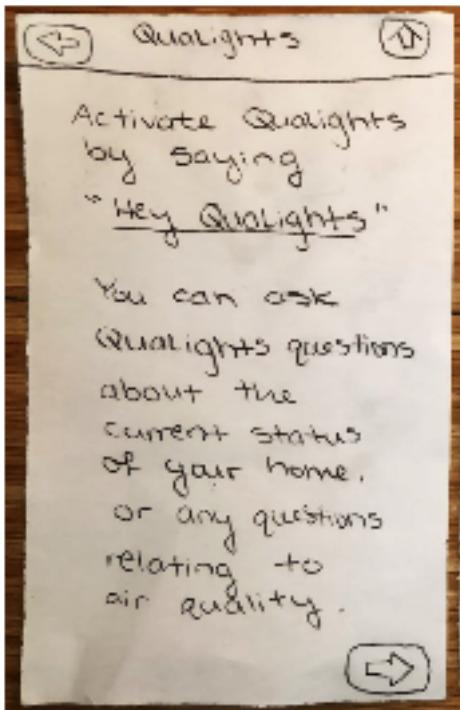


Figure 2. Upon setting up the QuaLights device, users are made aware of the voice control that QuaLights is capable of.



Figure 3. Once the device detects that the user is speaking to it, the ring light will light up in rainbow so the user knows that QuaLights is listening and that they can proceed.

Task 2: Monitor changes in a home's air quality

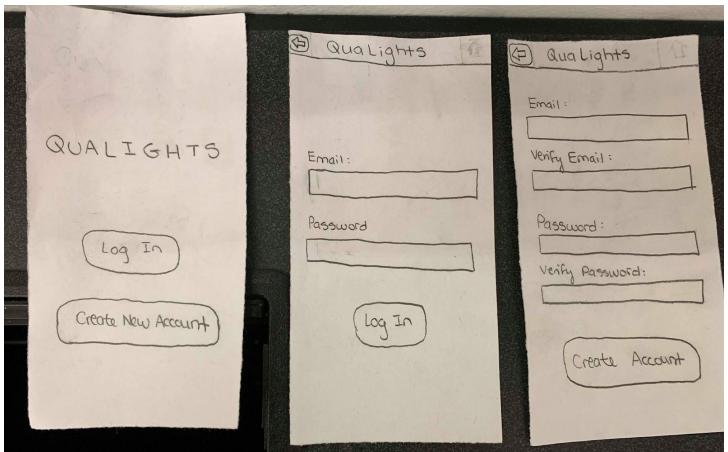


Figure 4. Before setting up and personalizing the device users will have to either log in with an existing account or create a new one.

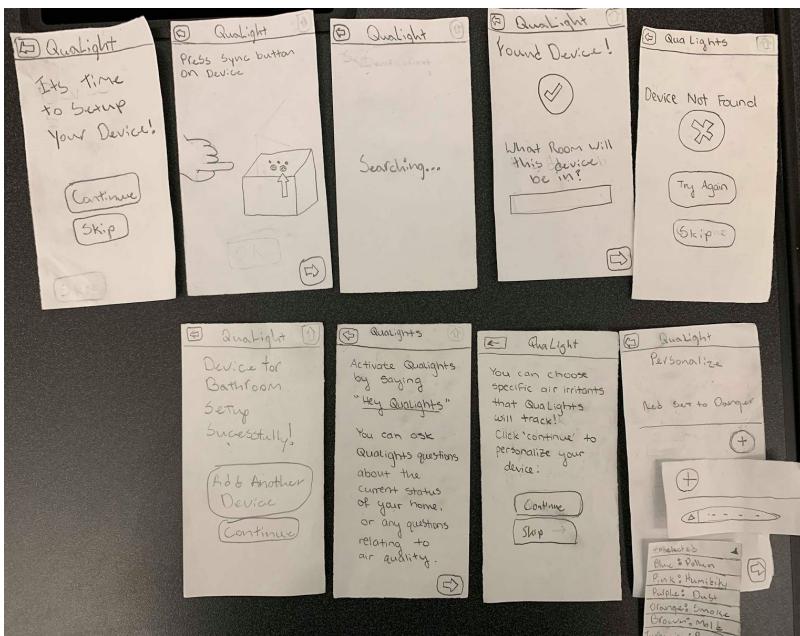


Figure 5. The QuaLights app will guide the user through the process of adding a new device.

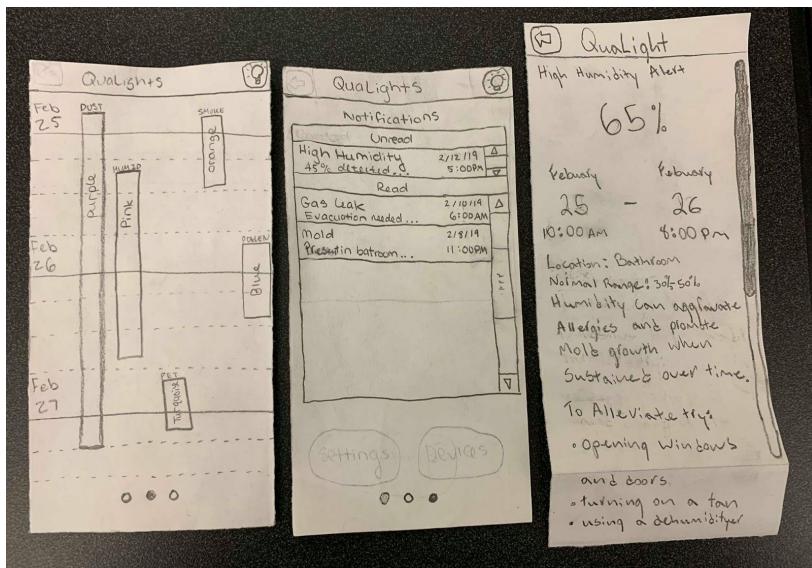


Figure 8. Once a user receives a notification, they can look on the app and learn more information about it including next steps.

Digital Mockup

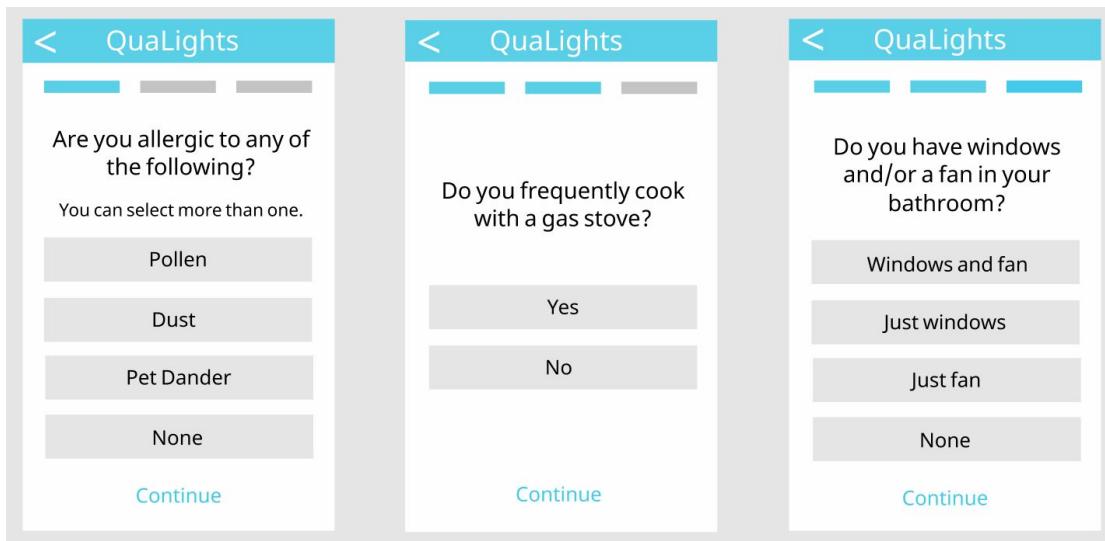
Critique From Section

After discussing with our teaching assistants during section, we decided to expand our Task 1: Educate self about potential air quality hazards so that the user can interact more with the app for this task. To do this we added a quick survey users would fill out upon set up so that they can start thinking about their current living situation in terms of air quality. In addition, every month the app will compile all the data it has tracked into a monthly air quality report so that users can monitor the overall air quality of their home over longer periods of time. Since we flushed out the features in our app more, we also decided to omit the voice interaction and control for our device since we felt it was no longer necessary with the additional education features in our app. Originally, we had the voice control so that users can ask QuaLights questions about air quality, but the app gives the user all the information they need about the air irritants they care about so there is no need to talk to the device.

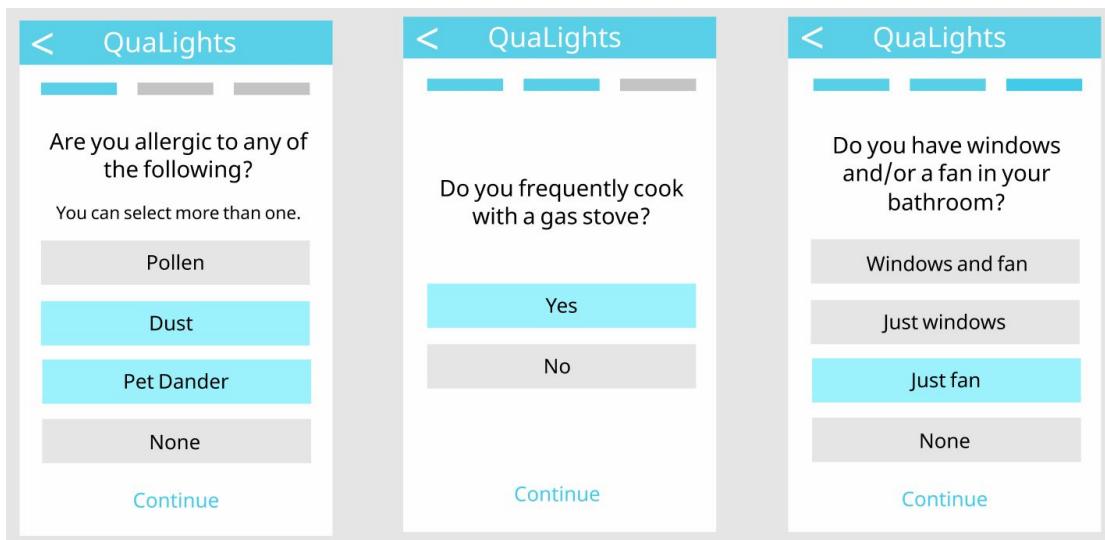
Digital Mockup Design Decisions Discussion

Throughout the process of transitioning from a paper prototype to a digital mockup, the main functionality of our app stayed the same, but it was the more minute aspects of the app that we had to make some design decisions for. For example, we had to now decide on a color scheme for our app since our paper prototype was just in black and white. We chose a light blue and white color theme for a clean and calm aesthetic versus something with more colors since we wanted to keep our interface simple. As for scrolling, we omitted the scroll bars since that looked too cluttered and instead used a fade at the bottom of screens to represent that they are scrollable. On the High humidity alert screen we decided to place information into collapsible sections to prevent the “wall of text” look and make the information more readable for the user.

Task 1 : Educate self about potential air quality hazards



When the user first sets up the device and opens up the app, they are prompted to answer the above questions during the setup phase of the app. These questions serve a dual purpose, firstly to set up what air quality factors QuaLights will specifically monitor for and secondly to make users think about air quality and learn about potential air quality hazards in relation to their current living situation.

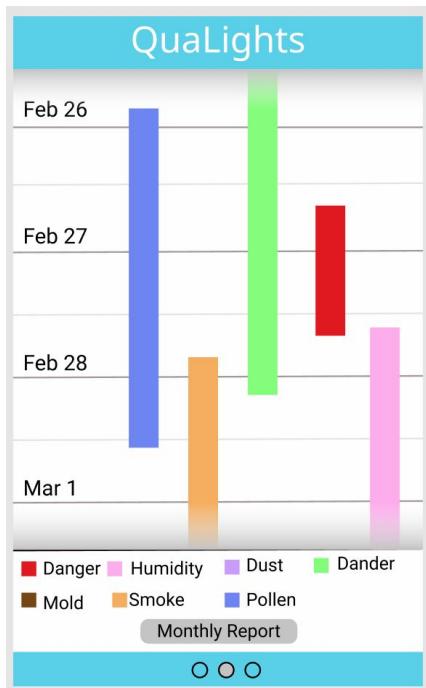


The user then selects answers to each question.

The image shows three separate mobile application screens from the QuaLights setup process. Each screen has a blue header bar with the QuaLights logo and a back arrow.

- Screen 1:** Text: "Based on your responses, your QuaLights device is set up to track the following irritants and will light up to the corresponding colors if it detects the following :". Below are four dropdown menus:
 - Purple set to Dust
 - Green set to Pet Dander
 - Pink set to Humidity
 - Orange set to Smoke
 A "Continue" button is at the bottom.
- Screen 2:** Text: "Based on your responses, your QuaLights device is set up to track the following irritants and will light up to the corresponding colors if it detects the following :". Below are four dropdown menus:
 - Purple set to Dust
 - Green set to Pet Dander
 - A list of 4 recommendations for Pet Dander:
 - Keep pets out of your bedroom.
 - Close the doors to bedrooms when you are not home to keep pets out.
 - Cover vents with dense material like cheesecloth.
 - Wash and change your animal's favorite furniture and toys often.
 A "Continue" button is at the bottom.
- Screen 3:** Text: "Based on your responses, your QuaLights device is set up to track the following irritants and will light up to the corresponding colors if it detects the following :". Below are four dropdown menus:
 - Purple set to Dust
 - Green set to Pet Dander
 - Pink set to Humidity
 - A list of 2 recommendations for Humidity:
 - Ideal humidity levels should be around 30 - 50%
 - We recommend placing a QuaLights device in your bathroom since unattended high humidity can lead to mold

As a result of the users selections, QuaLights will suggest and set up air quality hazards to monitor. Clicking on each dropdown bar will bring up more information on what to do for each hazard. Additional hazard monitoring can be added in setting after initial setup is completed.

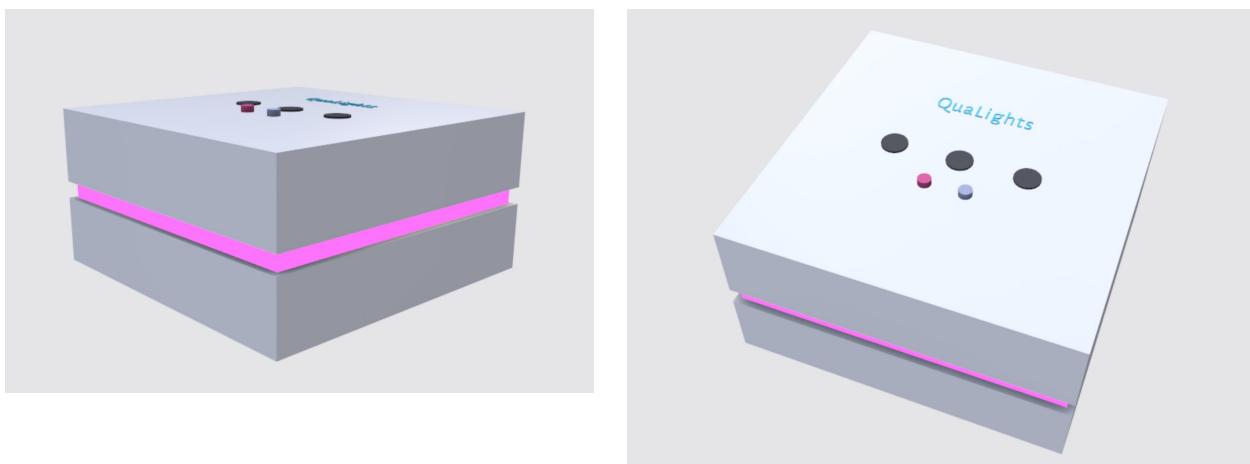


Another way QuaLights allows users to educate themselves about air quality is through monthly air quality reports that can be accessed from the home screen.

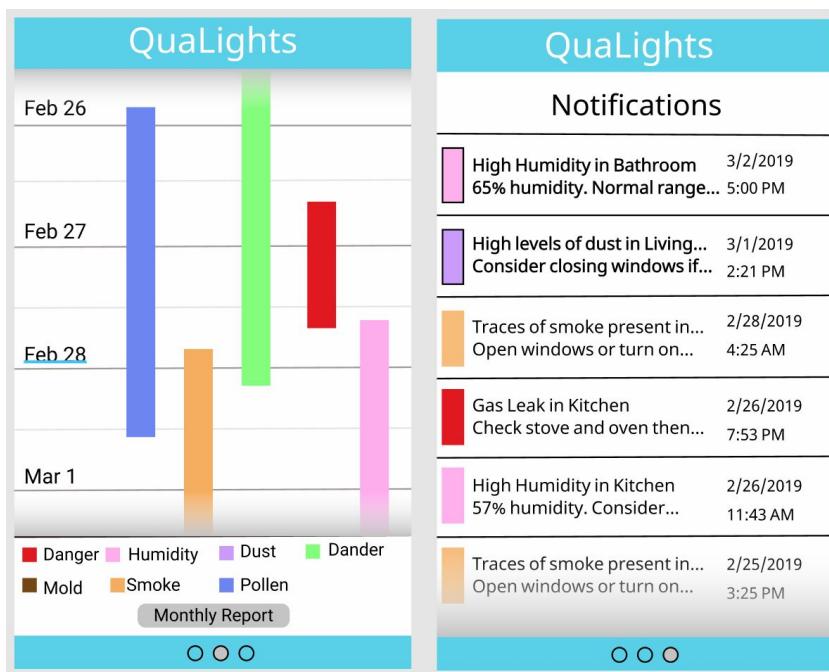


The user can view an overview of the air quality notification and the hours of affected air quality, as well as view breakdowns for specific devices and locations. Selecting portions of the pie chart will bring up additional information.

Task 2 : Monitor changes in a home's air quality



The QuaLights device lights up with a pink notification for high humidity in the room it is placed in.



Following a notification that causes QuaLights to light up, the user can find more information about the notification on the home screen (left). This shows a timeline of notifications and their duration over hours or days where the conditions that caused the notification were sustained. If the user swipes right they will find a list of notifications in the order that they first appeared, with unread notifications appearing bolded and read notifications unbolted. The user can navigate to more information about the current state of their home from either the bars on the timeline or the notifications.

QuaLights

High Humidity Alert

65 percent

March 2 through March 3

Location: Bathroom

More Information

A healthy range of humidity in a home is between 30 and 50%. When there is high humidity in the home, bacteria and viruses that cause respiratory illnesses thrive and there is increased likely hood of mold growth which can cause symptoms such as eye irritation, wheezing or even dangerous lung infections.

Next Steps

To decrease humidity in your bathroom, try:

- Using built in ventilation such as fans
- Opening any windows and doors when the shower is in use
- Placing a dehumidifier in the affected room

When the user clicks on the notification they are presented with the screen on the left. This provides specific information such as the room that is affected by the poor air quality and the severity of problem. There is also more information about how the irritant affects the health of occupants if the problem is not addressed (middle) and information about the best ways to improve this aspect of air quality (right).

Discussion

Lessons From the Process of Iterative Design

From the process of iterative design, we learned to utilize existing resources, avoid over complicating our design, and to continually evaluate for ease of use. In evaluating our initial design that included a voice interface and a projection onto a home's walls, we quickly realized that it would be a poor design choice to have a projection on the walls because of a projection's intrusiveness, and redundancy. Essentially, our projection would show the same information that a smartphone or tablet app would show, and would be increasingly difficult to use, so we decided that it would be more effective to move our interface over to an app. In addition to deciding to use the existing interface of a smartphone or tablet, we discovered that we sometimes made decisions about design usability without understanding how they impacted our tasks. For example, it was difficult to retain our education task in our early voice controlled, projection based design because we focused significantly on making sure our complicated design made sense, rather than on how to make our product educational. After we decided to use an app to interface with our product rather than voice and projections, we iterated through designs that used a variety of buttons, rather than swiping, and generally more intuitive screens. By iterating through these early designs, we brought about our final digital prototype that accomplishes our tasks, and is intuitive to use.

How Our Process Impacted Our Final Design

The process shaped our final design by allowing us to identify and retain the most effective elements, while we discovered and modified the subpar aspects of our design. The biggest change we made is how we transitioned our design from using projections and voice control to being an app, and we were able to identify this as a positive change because of the previous iterations we had been through. Through each iteration, it became increasingly apparent how cumbersome our voice interface would be, which heavily influenced our final design as we overhauled the voice interface and projections entirely.

How Our Tasks Have Changed

The two tasks that we chose to focus on were general home air quality monitoring, and education about indoor air quality. While our education task has mostly remained the same, our general home air quality monitoring task has changed considerably. In our initial design, the education task had a smaller role compared to in our final design, where education is prominent in our device's setup. Additionally, in our original design we thought that the hardware component would light up yellow for "generally poor" air

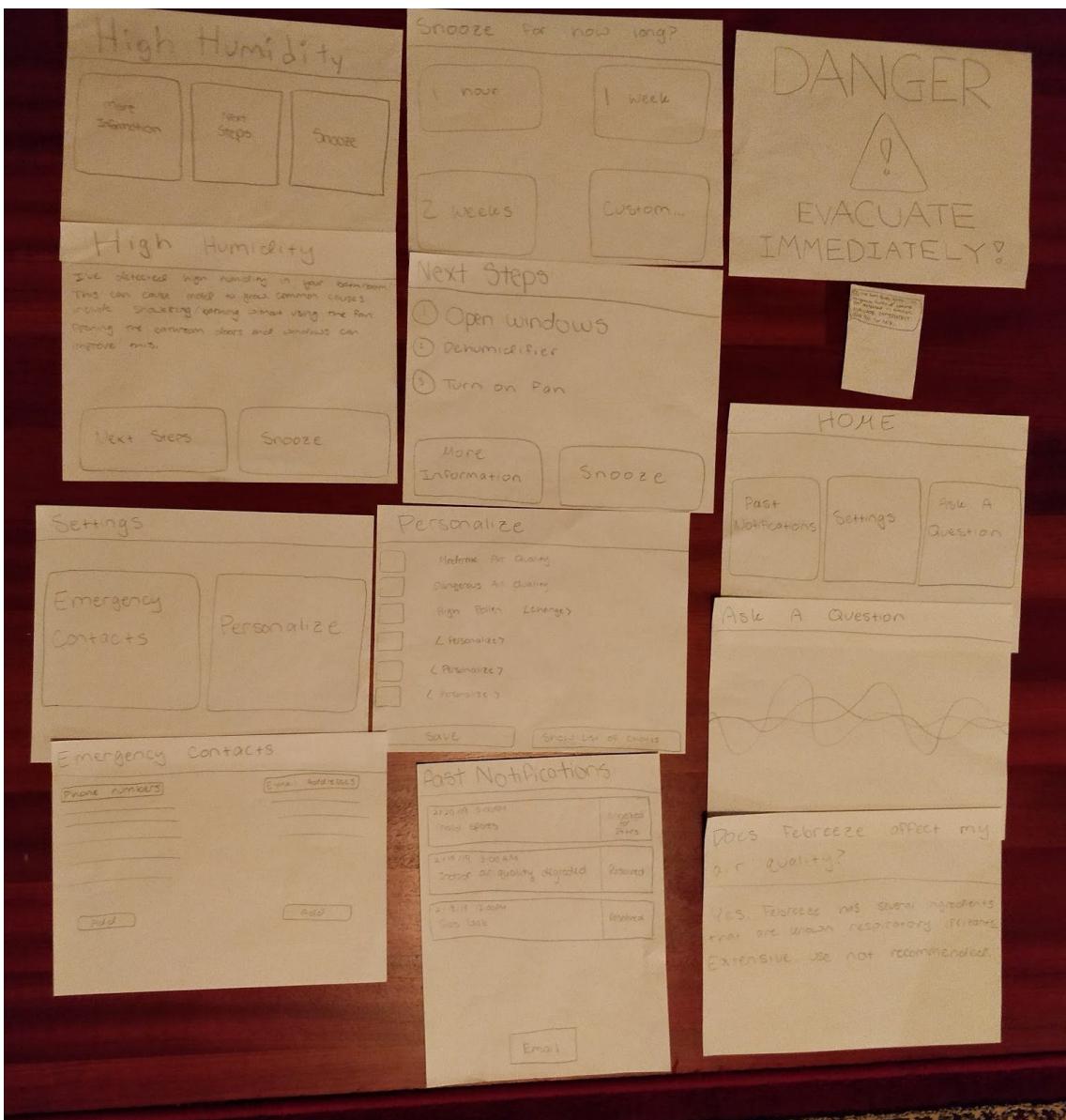
quality indoors, but we realized how vague and redundant this was, and consequently decided to only have our hardware component light up for specific irritants in our final design. Ultimately, our education task now has an integral role in our design, and our general indoor air quality monitoring task has become increasingly refined.

Reflection On Iterations

I think that we could have benefitted from more iterations because we made major changes throughout our previous iterations, and it would be helpful to further refine our current design through additional iterations. Throughout the iterative process, our design has become significantly more effective, but it has changed so much throughout the process that our final design came about relatively recently in the process. While we have certainly refined our app, we feel that it could be further improved throughout more iterations.

Appendix

Materials from Heuristic Tests

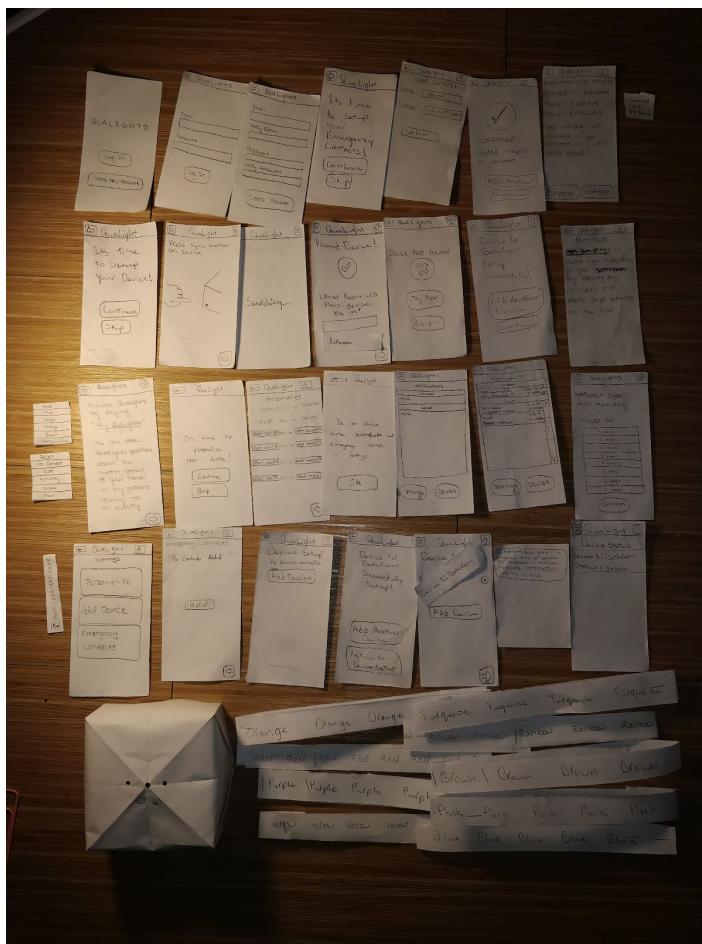


Task descriptions from first usability test

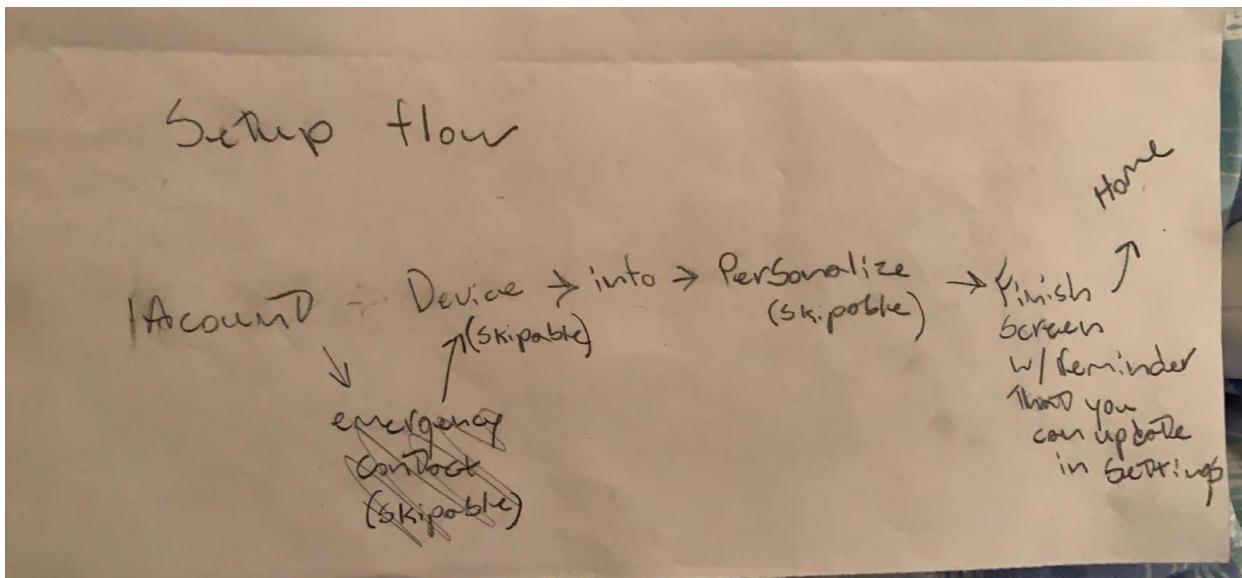
Task Description 1 (Read to participants): You have recently been concerned about how humid it has been in your bathroom and worried that it might have effects on you health or cause mold in your house. To track the humidity and hopefully avoid any problems, you have purchased a QuaLights device which you have just brought home and you are ready to begin tracking the humidity in your home. Your task is to setup the device and wait for a notification then react appropriately.

Task Description 2 (Read to participants): You have recently bought a bunch of cleaning products and as you begin to use them you see your Qualights device and wonder how the Febreeze that you are spraying all over your home to make it smell better will affect your air quality. Your task is to find more information from your QuaLights device.

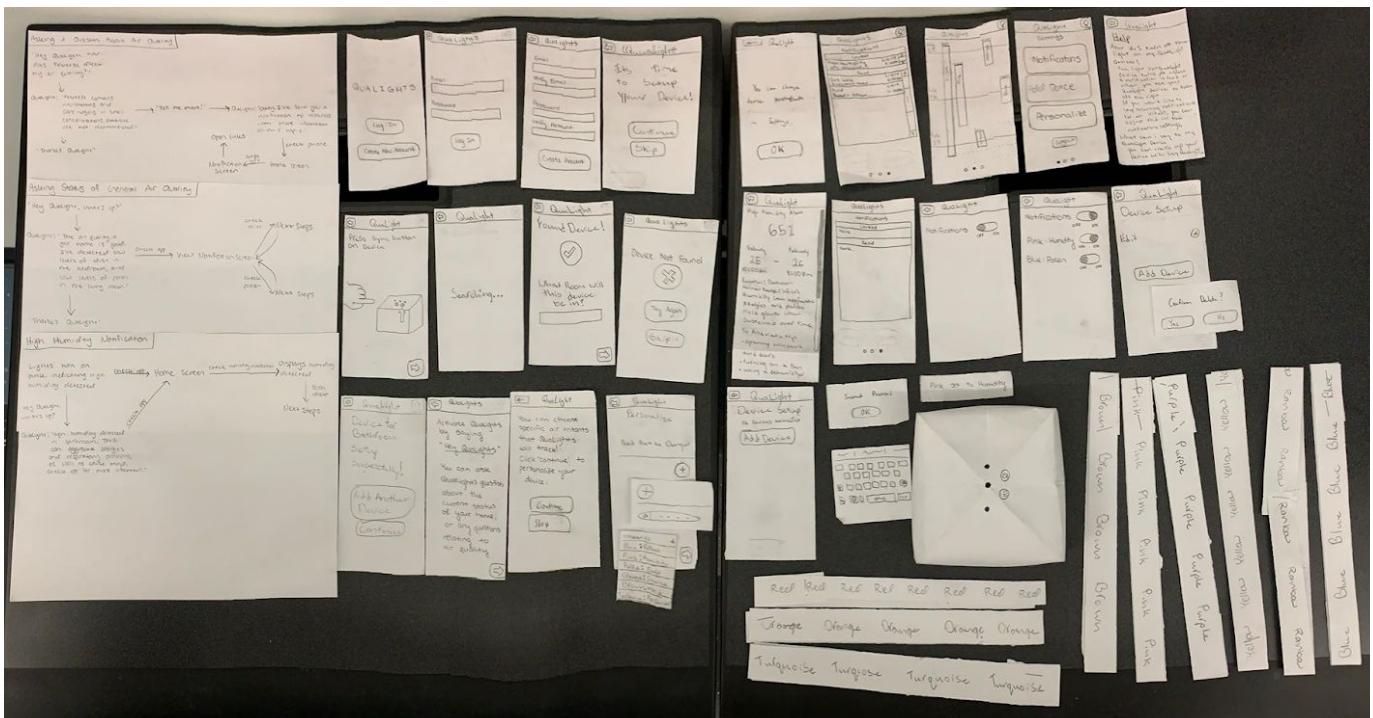
Overview of prototype from second usability test



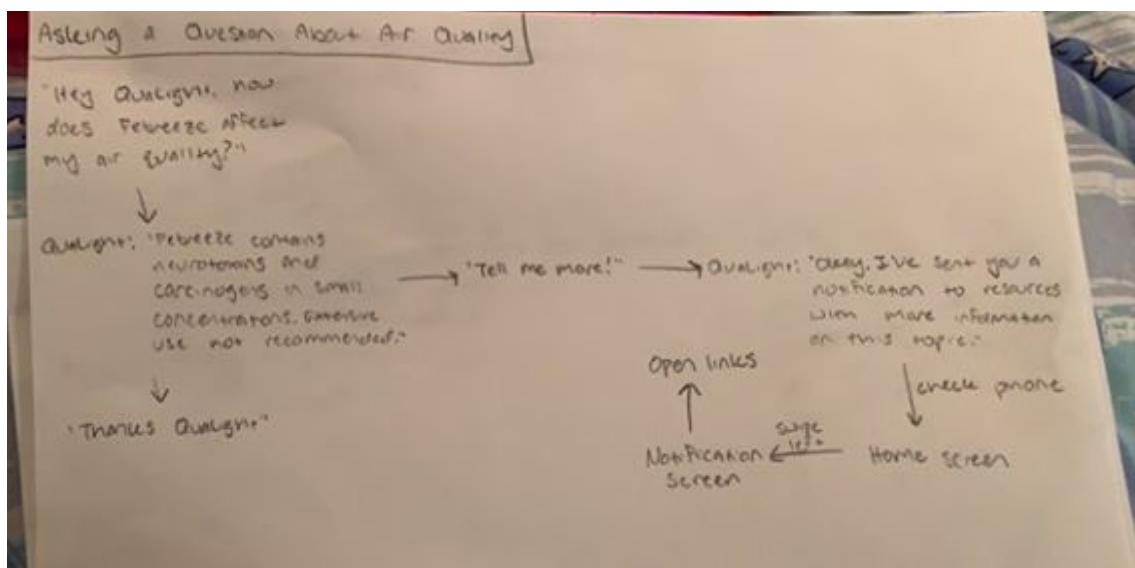
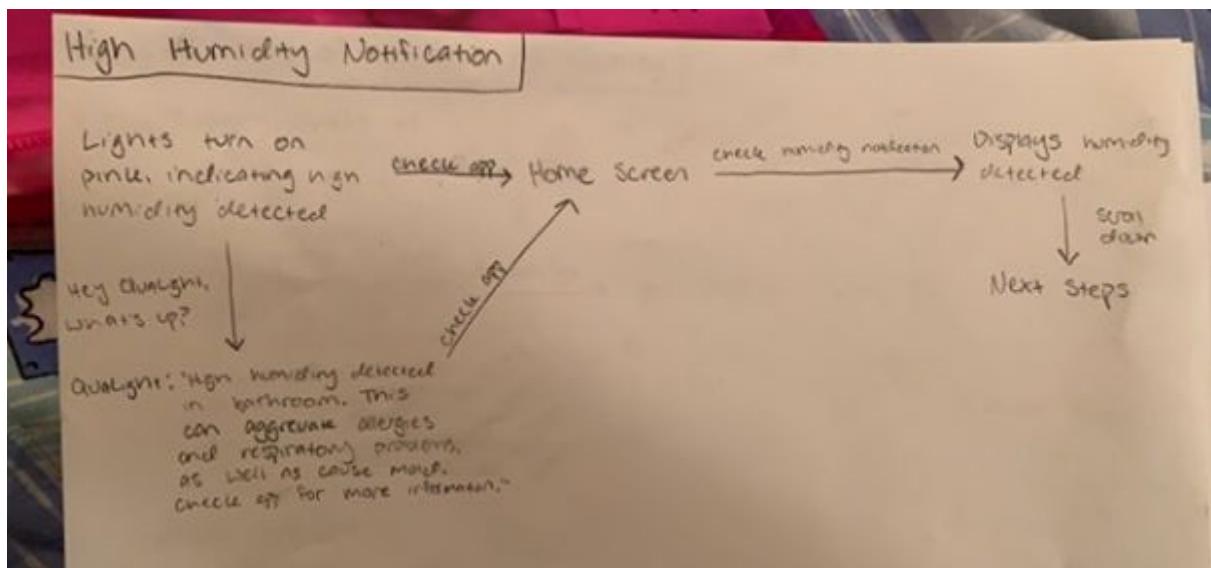
Setup flow used in second usability test



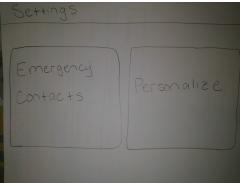
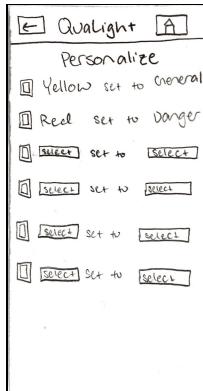
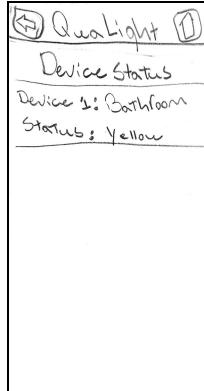
Overview image of prototype from third usability test

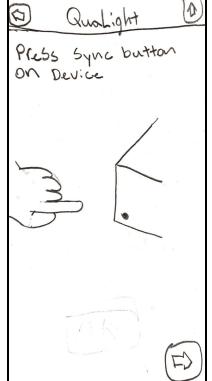


Usability Test Task Flows

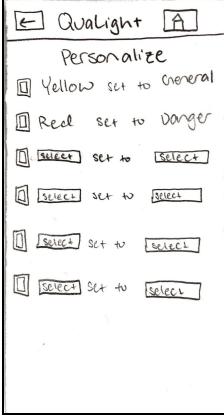
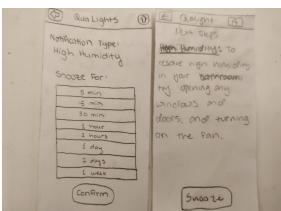
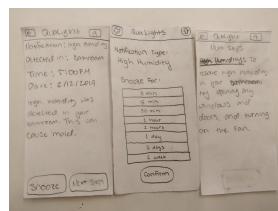


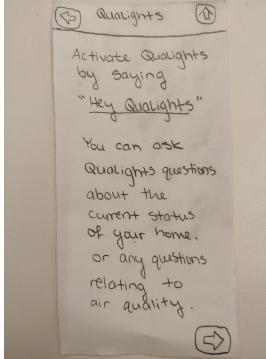
Critical problems from Heuristic evaluations:

Image	Issue	Revision Image(s)	Revision
No image	Heuristic groups felt that an app would better suit the functionality that we desired and would decrease the overall confusion in navigation with the device	No image	Translated projection screens into app screens
	Returning to home screen/state unsupported Heuristic: User control		Home and back buttons added to relevant screens
No image, missing from prototype	No information on how the whole system works and how the devices are interconnected Heuristic: Help & Documentation		Included status screen for connected devices, including location.

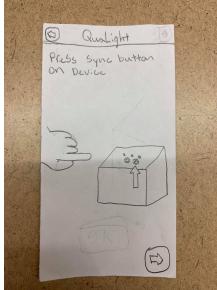
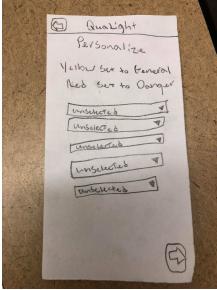
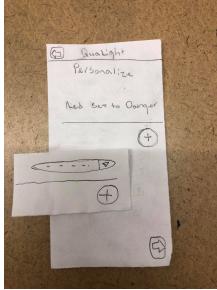
No image, missing from prototype	No information on how device connects to phone Heuristic: Help & Documentation		Included informational screens during device set up
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Critical Problems from Usability Test 1:

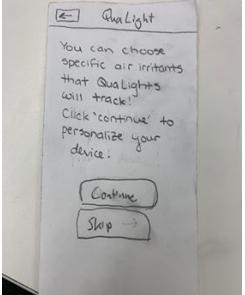
Image of Problem	Description of Problem	Image of Revision	Description of Revision
	RP was not sure how to work the color buttons on the personalize screen		Added dropdown menus for each color option and hazard option instead of a separate screen
	RP was unsure what to do after they had snoozed a notification		Removed snooze button from next steps so it can only be accessed from the first notification screen. The confirm button will return to the first screen with an indicator that the notification was snoozed.

No image	RP was unsure what to say to the device when asked to find information		Added information slide detailing how to verbally query QuaLight
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Critical Problems from Usability Test 2:

Image of Problem	Description of Problem	Image of Revision	Description of Revision
	Illustration for the QuaLights device was inconsistent with what the device actually looked like.		Changed the illustration so it reflects how the device actually looks like and included an arrow to clearly show where the user should press.
	MZ was confused what "Yellow set to General" meant and also how the personalization selection worked.		Took out "Yellow set to General" since we decided it did not make sense to have an overall air quality indicator when the user can personalize specific irritants they want to be notified about. Changed how users can personalize which irritants they want to be notified about using "+" to make it clear they are adding something.

Critical Problems from usability test 3:

Image of Problem	Description of Problem	Severity	Image of Revision	Description of Revision
	KR was confused what it meant to "personalize" the device.	3		Added text to the personalization set up screen that explains what the user is about to personalize.

Contribution Statement:

Bailee: 25% created and formatted document, created appendix, worked on original paper prototype, and final paper prototype

Joy: 25% worked on Discussion, testing process sections

Pei Lee: 25% worked on original paper prototype, final paper prototype, digital mockup, and problem and solution overview

Daniel: 25% worked on Testing Results section