ACTIVITY-BASED LIVING IN MULTI-PURPOSE ROOMS

How to make the user aware of activities and consequences?

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ABSTRACT

This report describes the data-enabled design approach that was applied to the project where the aim was to raise awareness about the consequences of activities on air quality. In the contextual step, a sensor probe was installed in a participants house to explore the environment and behavior of the participant. This step gave us the insights that the air quality is influenced by activities that happen in the same room. This inspired us to explore how to make the user aware of the consequences of activities on air quality. In the informed step, an air controller was designed to raise the user's awareness. In three iterations, this prototype was explored and evaluated. It was found that suggestions and facts about air quality were appreciated, but that the participant did not interact with the prototype as intended. From this, we could conclude that our goal of raising awareness about air quality was not achieved with our proposed design. However, some interesting insights were gathered in the process, that can be of use for future work on improving air quality.

KEYWORDS

Data enabled design, Air quality, Multi-purpose rooms, Awareness, Activity-based living

Figure 1 - Prototype of the informed step

INTRODUCTION

In our homes, we do many different activities. All of these activities have a different effect on the air quality in the house. Doing the laundry can have a different effect than an intense gaming session. However, both can still have a bigger influence on air quality than one might think. In bigger spaces, this should not be an issue, but when every activity takes place in the same, small room, such as a studio, air quality is a bigger issue. In this report, we will refer to this as multi-purpose rooms. We found this out during our contextual step where we placed sensors in such a room to measure the air quality. We did this to explore out how to improve a healthier living environment by either changing the environment and or the behavior and experience of the user. How we came to the activities in studios and what we did to help the user it will be explained in this pictorial.

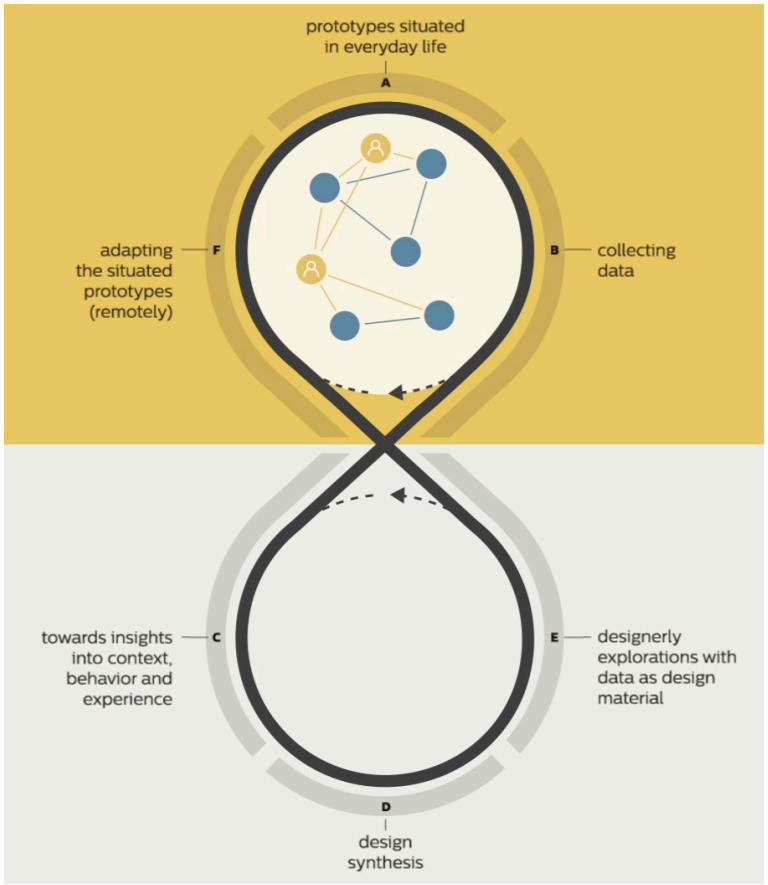

Figure 2 - Data-enabled design method

PROCESS

In the course, we used the Data Enabled Design approach, as proposed by Van Kollenburg & Bogers [3], which can be seen in figure 2. This eight shape approach starts with using sensors to collect data. This is called the contextual step in which insights in the behavior of the participants is gained. This is done by collecting the sensor data and conducting interviews about this data. This contextual step serves as an insight gaining step to start the next step, which is the informed step. In this step design explorations are conducted based on the earlier gained insights. The exploring is done by deploying multiple iterations of prototypes. With each prototype, we were trying to find new details or data. In total, 3 iterations were performed in the informed step. After both the contextual and informed step we conclude on what we learned and on our direction. See figure 3 for an overview of the process.

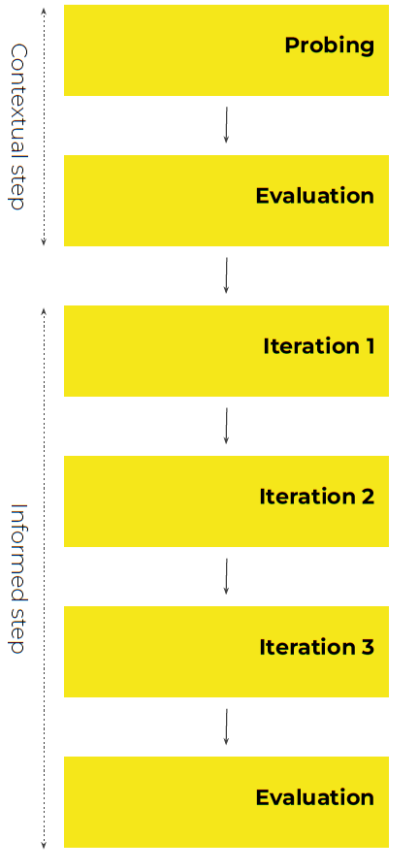

Figure 3 - Taken steps

CONTEXTUAL STEP

We started the contextual step by placing a probe in the room of our participant, see figure 4 & 5. This probe served to collect data, which we would use to get more insights into the everyday life of our participant. The probe was made by using a microcontroller ESP32. To gather data we used a dust sensor that measures airborne particles, and a BME680 sensor that collects temperature, humidity, altitude and gas. All gathered data was sent using an open-source communication framework called OOCSI [5] and stored in the Data Foundry database [2]. The altitude and gas data were excluded because both seemed to show wrong measurements. The dust sensor did not work optimally, as the measurements fluctuated often with very sudden, high peaks. However, instead of dust levels, the sensor seemed to show motion in the room, creating peaks when the participant moved around a lot. Even though we did not get detailed insights into dust levels, the incidental findings of the sensor gave extra insights on how the participant lived and moved in his room, for example, indications of activities. The data that was gathered showed some recurring patterns, for example when he was sleeping or when he had people over.

To get more insight into these patterns and the collected data in general, we interviewed the participant. We asked him questions about his everyday life, such as habits or patterns and about specific events during the data gathering. We also showed him the data that was visualized using RawGraph [6] (see figure 6) and asked if the participant could explain what he was doing during interesting data points. Together with the participant, we tried to make sense of the data gathered. Our participant was able to give us more insights in his habits and he could explain certain interesting data points, such as temperature increases at night or when he turned on the cooking hood even when he was not cooking. This gave us the impression that he was using other mediums than windows to influence the air quality in the room. Together, we were able to establish an overview of activities that were happening, or reasons that could influence the sensor measurements. From this, we could see that the measurements differ during activities, so the air quality can also change during different activities. Examples of this are a peak in humidity during the time of a shower, or a rise in temperature while sleeping due to being cold. The changes in measurements (and therefore in activities) were not that distinct that we could take the data and say ‘at this time activity A occurred, and here he switched to activity B’. However, based on the information from the interview combined with the data, we could see different values from the sensor during different activities. This was an interesting observation and inspired us to look into how activities influence the air quality in small multi-purpose rooms.

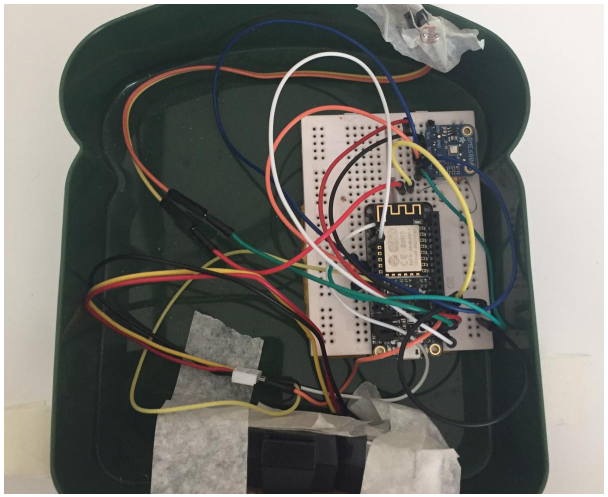

Figure 4 - Probe contextual step

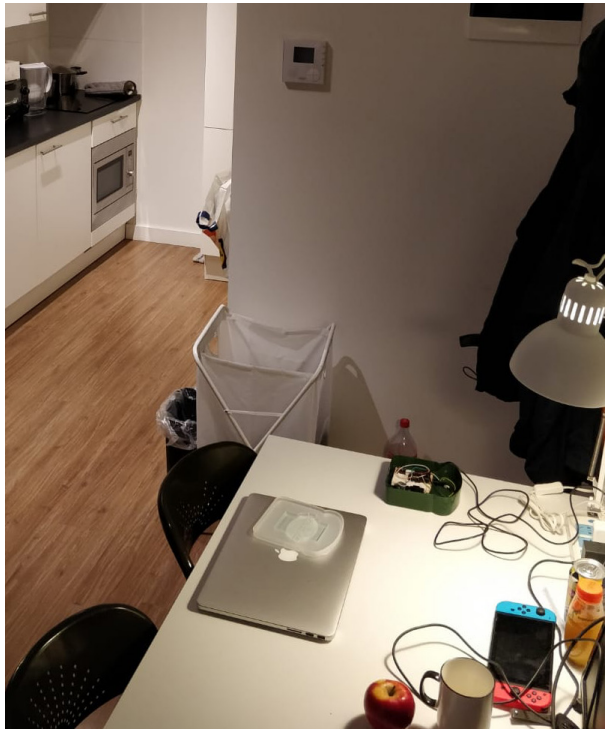

Figure 5 - Particpants place with probe on desk

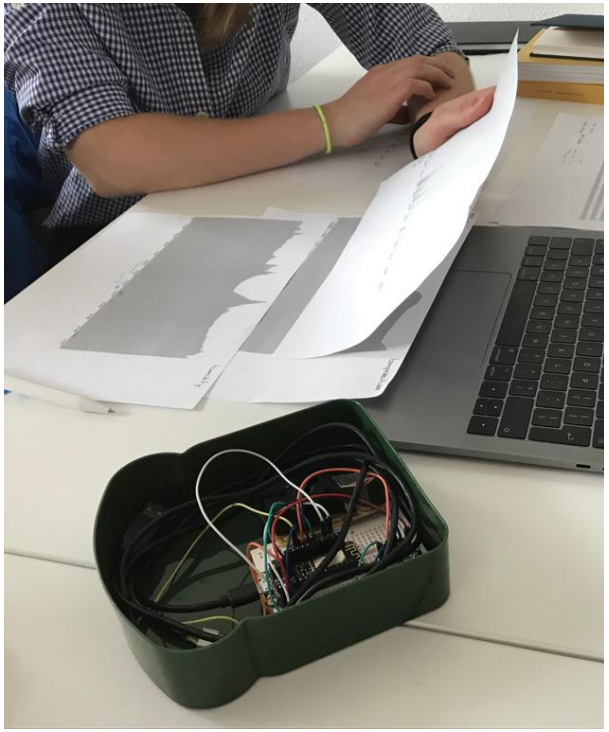

Figure 6 - Data review with the particepant

INFORMED STEP

Based on the inspiration from the contextual step, we defined our project direction, which we have called ‘activity-based living in multi-purpose rooms’. What this implies, is that multiple activities take place in a single room. We eat where we work, we work where we sleep, and we sleep where we cook. These activities all happen in the same room, making it a multi-purpose room.

The activities that are performed in a room all influence the air quality. For example, cooking can spread fumes and showering can increase the humidity. We are interested in seeing how the consequences of these actions influence the air quality in the room. However, what interests us most, is seeing how we can make our user aware of these consequences of the actions he is performing. Ideally, we would like to understand how his actions influence the air quality, so he can act on it, ensuring his room is always in a healthy state.

Our interest and goal have led us to create Roomy, a smart air controller, see figure 7. Roomy is an air controller that has a fan in the back that should purify the air in the room. It consists of three parts: an activity dial recommended fan settings and a fan controller.

Activity dial:

On this dial, the participant can enter the activity he is currently doing. Activities include amongst others cooking, showering, working and not at home. The activity corresponds to a recommended fan speed.

Recommended fan speed:

Based on the activity entered by the participant, a recommended fan speed is shown. The recommendation can vary from 1 (weak) to 5 (strong) and is shown through LEDs. At the start of the testing phase, the recommended settings were fixed. However, over time, we started to make changes to the recommendations to see how the participant would respond to it.

Fan controller:

The actual fan can be controlled with a slider. The user has full control over this slider and thus can decide to match the recommended setting or ignore the setting.

This is the concept used during the informed step. We went through several iterations to improve the performance and to learn from our participant’s behavior. The next paragraphs will explain the iterations and their outcomes.

Figure 7 - Design and working informed step

Figure 8 - Device location during iteration 1

ITERATION 1

In the first iteration, our prototype was placed in the home of our participant. We asked him to input his activity as accurately as possible. At this stage, the prototype was still a kind of data-gathering probe, as we as researchers did not actively change anything. We started by observing how the participant responded to Roomy.

The goal of this iteration and the entire informed step is to learn how to create awareness about the consequences of actions, and if Roomy is a way to achieve this. However, the participant was told that we were investigating how activities performed in the room relate to air quality. This was done in order not to somehow influence or bias the participant beforehand.

During this iteration, we struggled with the hardware. The prototype was not working as intended, which caused a loss of data at several moments. This also made the prototype unreliable.

What was also found from this iteration, was that there was a lack of responsiveness from the prototype. When the participant entered his activity, there was not a clear reaction from the prototype to give him feedback that his action was successful. This lack of responsiveness resulted in a lack of trust from the participant. He was unsure whether or not his input was registered, and therefore started to doubt if everything was working the way it should.

ITERATION 2

For iteration 2, the concept and the prototype remained the same, but a few things were adapted to increase the performance of the prototype. We updated the hardware, such as increasing the connection stability, to ensure that the prototype would work properly. Furthermore, based on the participant's feedback, we added more responsiveness by changing the color of the LEDs for the recommended fan speed when an activity changed. This made it clear for the participant that the prototype registered the activity input, even if the recommended fan speed remained the same. Since the first iteration did not work smoothly, we decided to have the participant use the prototype of the second iteration without interference from our side. The aim for this was for the user to experience the prototype how it should, with good responsiveness.

This iteration resulted in more stable and reliable data. Moreover, the participant expressed that the added responsiveness of the prototype was appreciated. It allowed him to get feedback on his actions, so he could see that his actions were registered.

Figure 9 - Device location during iteration 2 and 3

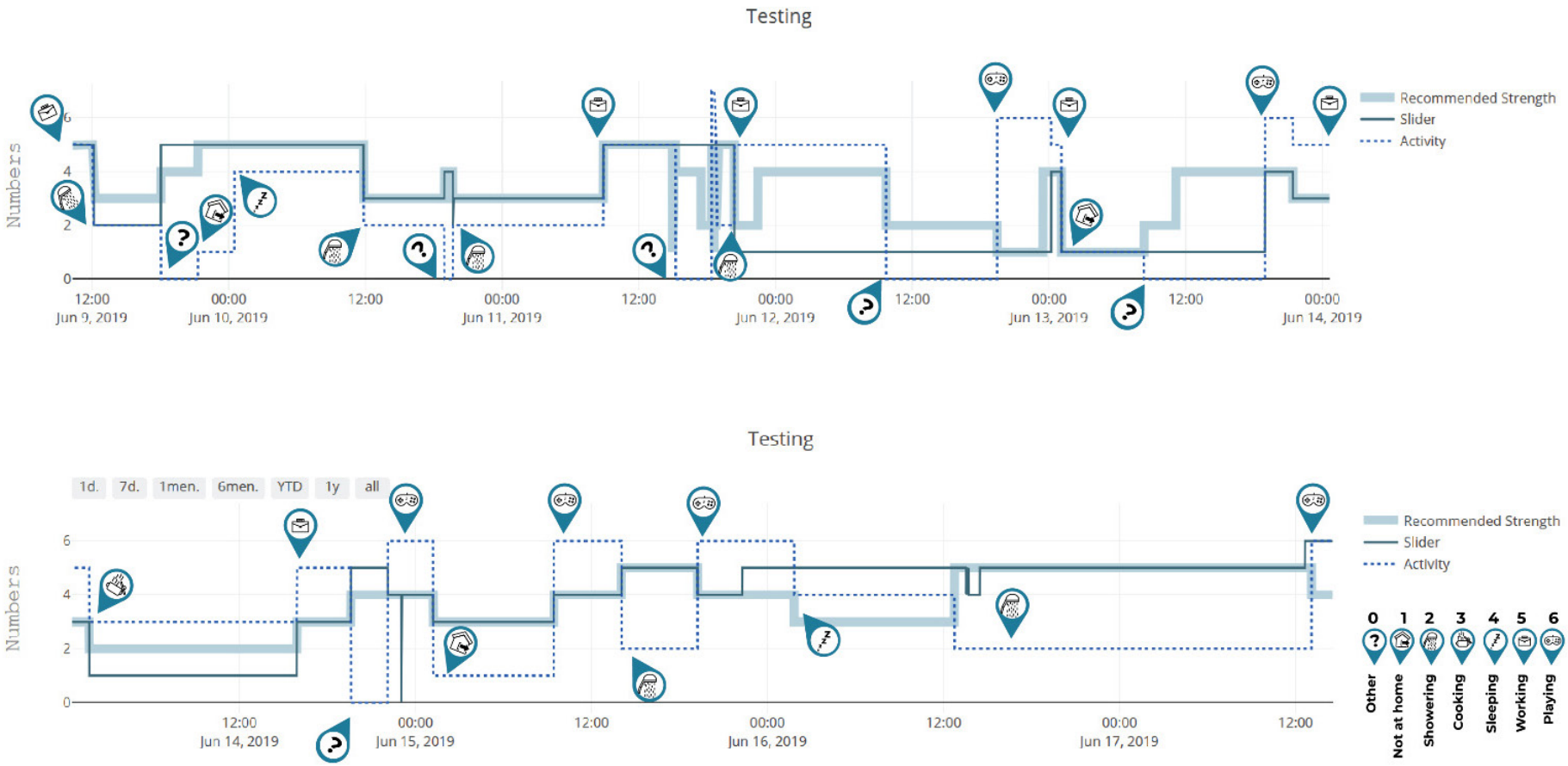

Figure 10 - Activity data

ITERATION 3

Since the second iteration yielded in a stable prototype, it was time to interfere with the settings proposed by the prototype. Therefore, in iteration 3, we introduced the participant to Roomy's voice. This was done through a chatbot and through a webpage.

The chatbot was a chat in Whatsapp, where the participant was messaged by Roomy in a unique manner, making sure it was clear that Roomy was sending the messages. The messages sent to the participant were notifications or questions. See figure 12 for examples. The participant received notifications when the webpage was updated with information. The webpage included the tips and information like the perfect settings for working environment, sleeping or some tips how to make studio room as healthy as possible (figure 11) . Roomy occasionally asked the participant questions to get a better understanding of the participant's feeling about Roomy and to see if there were ways in which to improve the interaction with Roomy.

The webpage was an informative page that the user could visit. It would contain the current value of temperature and humidity in the room, as well as tips or suggestions for the participant. The webpage was aimed to inform the participant about the state of his room, and to stimulate him into taking action about the current situation in the room.

Next, to adding Roomy's voice, we started interfering by remotely changing the recommended settings of the fan speed. The goal of this was to see if the participant noticed these changes and how it made him feel. The data that was gathered during this iteration can be seen in figure 10, where it is also visible when the recommended settings were changed.

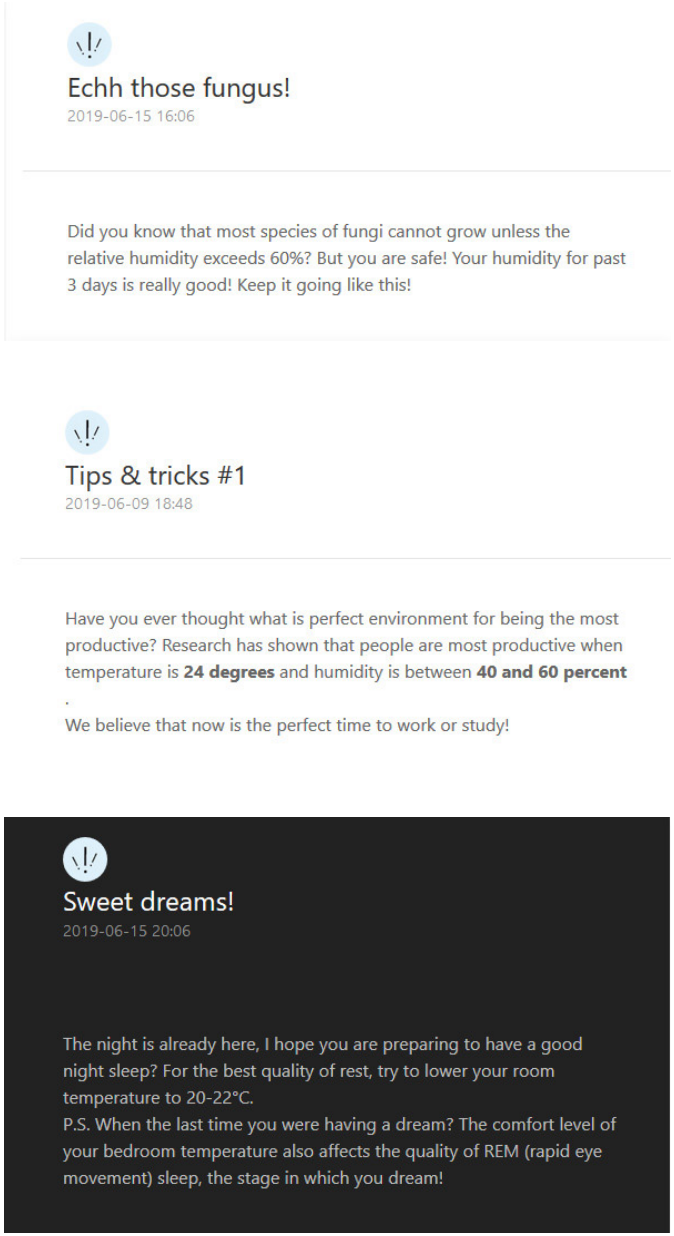

Figure 11 - Suggestions provided by Roomy on the webpage. Information retrieved from [1], [4], [7].

This iteration was concluded with an interview about the participant's overall experience, and with questions about actions or gathered data, see figure 10.

The participant mentioned that he appreciated the chatbot, as this added some life and personality to the prototype. Furthermore, the tips and suggestions on the webpage were appreciated by the participant. He mentioned that the tips taught him something about the ideal work environment for his room, which he liked.

When asked about how the participant experienced the study, he mentioned that he sometimes felt watched. This made him change his behavior to avoid prejudice from our side and made him sometimes feel slightly uncomfortable. Furthermore, the participant expressed that he had made some assumptions about the functioning of the prototype. These activities led to a certain behavior. For example, the participant said he thought that once an activity was set, the recommended settings would not change. Because of this assumption, he did not check the prototype anymore after entering an activity. This caused him to miss the change in recommended settings. Whenever he did notice that the current fan speed did not match the recommended fan speed, he would change the fan speed to match the recommended fan speed.

The data shows moments where the current fan speed and the recommended fan speed did not match. When asked about why this was the case, the participant mentioned that most likely he forgot to either update the fan speed or update the activity. Therefore, we can unfortunately not make any implications about these results.

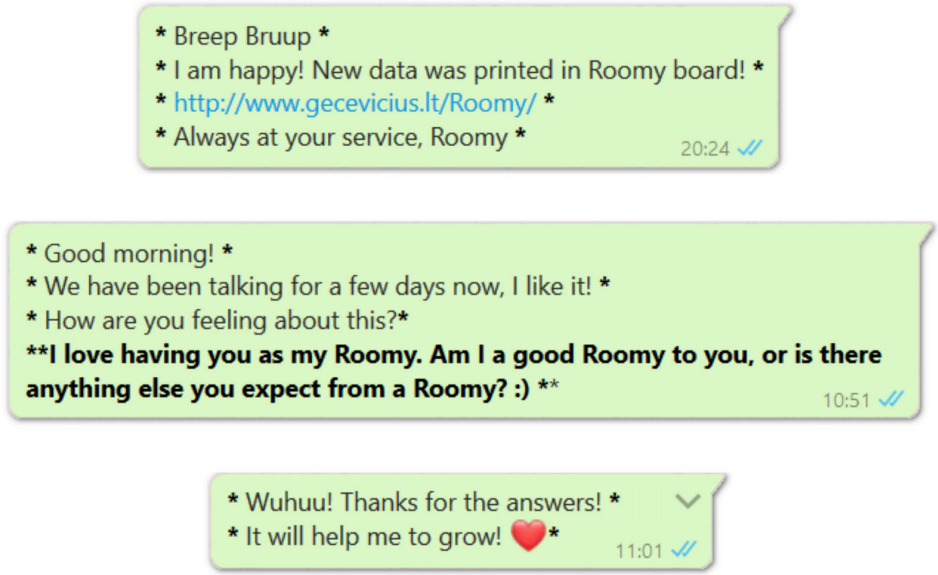

Figure 12 - Whatsapp messages as Roomy

The recommended fan speed settings were randomly chosen per activity. Also when this value was remotely changed, it was replaced by a random value. This was done because we were more interested in the participant's awareness and response to Roomy and the activities, than the actual activities he was performing. However, the participant seemed to have noticed that the values for the recommended fan speed were random since he mentioned that they made no sense to him and had him wonder what the values were based on. His trust in the system was already low, this occurrence did not help to increase this, which is unfortunate.

During the interview, the participant mentioned he would be interested in Roomy working the other way around. It currently links settings to activities, e.g. when cooking this setting is recommended. However, the participant expressed interest in linking activities to settings, e.g. these settings are ideal for working out. This approach is not one we have explored, but it sounds interesting. Therefore, if we were to continue with this project, exploring how to link activities to settings would be the first step.

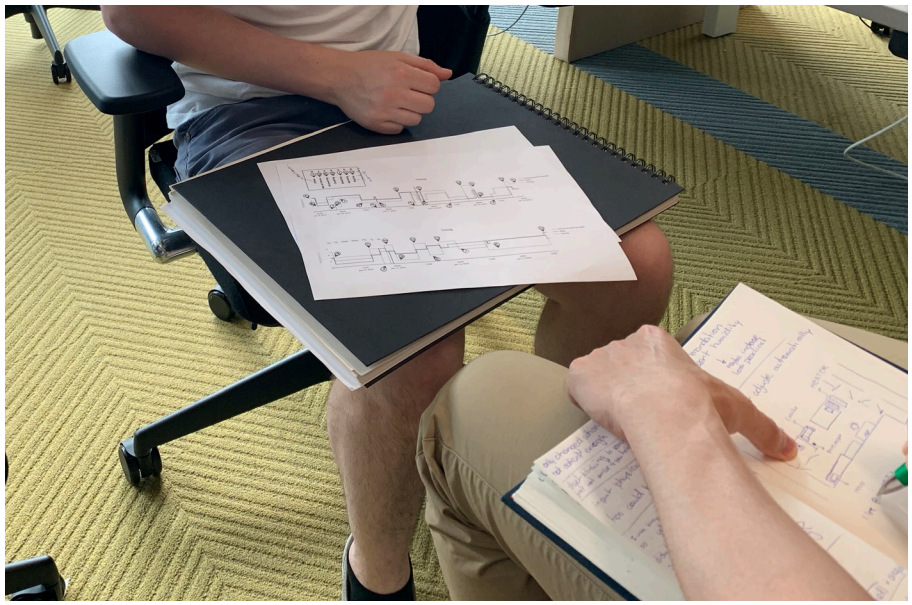

Figure 13 - Interview/data review with participant

DISCUSSION

The overall process we went through in this course is good. We took a data-enabled design approach and went through the loop several times. This allowed us to do multiple iterations, which has improved our concept and helped us gather more insights.

Even though the overall process was good, some exceptional parts did not as well as intended. For example, at the beginning of the informed step, we faced hardware issues. Together with connection issues, this resulted in very limited data that we gathered, and the data we did gather was not trusted. We were able to continue from here, but it did result in a drawback for the exit interview. We did not have data from the first week of testing and combined with our participant not being able to recall much from that period, our findings are not as strong as they could have been.

In hindsight, maybe we should have contacted the participant more often to check how everything went. This could have given us more insights in general, but also more specific experiences with each iteration. However, we purposefully did not contact our participant often, so that he would not be biased by something we said, and that he could experience everything by himself. This gave us an overview of the participant's behavior during the testing period and allowed us to map his experience over time. Even though the approach we took may not have yielded very specific information about each iteration we did, we were able to collect our participant's behavior and experience throughout the entire testing period. The approach we took in terms of participant contact, has resulted in some flaws, but also in interesting insights. Since we did not take the other approach, we cannot say anything about how that would influence our findings. It would therefore be interesting to see how the two approaches described above would influence findings and thus which approach is more suitable.

CONCLUSION

The results that come out of this project seem to indicate that Roomy has not helped the participant in gaining more awareness of the consequences of his activities on air quality. The tips and suggestions provided were nice and taught the participant something he did not know yet. Other than that, he did not see how Roomy has changed his behavior or increased his awareness. Therefore, the approach we took for raising awareness about air quality seems not to be the most efficient one.

However, we did gain some interesting insights. For example, the participant occasionally forgot to update the fan speed. This could be because it was not important enough to him, or he was not motivated enough to keep thinking about it. This is something to take into account for future iterations, as this influences the behavior of the participant. Next, we saw that the participant did not always see the logic in entering his activity, to which the room changed accordingly. This could be because of the difference in recommended fan speed per activity, or that the recommended fan speed was not grounded. The participant did express an interest in the system recommending an activity based on the current settings. This is the other way around of what we tried to do but shows an interesting direction to explore.

Therefore, we were not able to reach our design goal of raising awareness about air quality with Roomy. We were able, however, to gather insights that can help us further is reaching this design goal. Furthermore, we were introduced to a new concept for this topic that we are interested in exploring further in future iterations.

REFERENCES

1. Arundel, A. V., Sterling, E. M., Biggin, J. H., & Sterling, T. D. (1986). Indirect health effects of relative humidity in indoor environments. Environmental Health Perspectives, VOL. 65(3), 351–361. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1474709/pdf/envhper00436-0331.pdf
2. Data Foundry. (2019). Retrieved from https://data.id.tue.nl/
3. Kollenburg, V., & Eindhoven, U. (2019). Data-enabled design : a situated design approach that uses data as creative material when designing for intelligent ecosystems. Retrieved from https://pure.tue.nl/ws/portalfiles/portal/118827915/20190228_Bogers_Kollenburg.pdf
4. ohsrep.org.au. (2019). offices temperature and humidity what are the rules. Retrieved from http://www.ohsrep.org.au/hazards/call-centres/offices-temperature-and-humidity-what-are-the-rules
5. Oocsi.id.tue.nl. (2019). oocsi.id.tue.nl. Retrieved from http://oocsi.id.tue.nl
6. Rawgraphs. (2019). rawgraphs.io. Retrieved from https://rawgraphs.io
7. Sleepnumber.com. (2019). sleepnumber.com. Retrieved from https://blog.sleepnumber.com/how-does-humidity-affect-your-sleep/