Water Quality Information - A Generative Study of a Water Information Extension for a Weather Mobile Phone Application

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Abstract
In the human body, water is absolutely essential for controlling digestion, hydration, body temperature, and blood pressure. It has now become crucial to monitor, assess, and control water quality. At the moment, a water quality monitoring station called "Ada" on the Pace University campus in Pleasantville, New York is fitted with sensors that record pH, temperature, dissolved oxygen, salinity, and conductivity to gather real-time data on water quality. Having this station placed in every water body on the planet will help educate people about water and its real-time quality information. As there is no user interface available for it currently, people have no way of accessing this information and hence the general population is not aware that this information is crucial. Thus, we propose an extension design for an existing weather mobile application for water quality information by using HCI techniques such as interviews, field study, surveys, usability tests, and applied UX design rules and guidelines in this study. Users will be able to view the real-time water quality metrics and learn crucial details about water from their mobile phones, just like they can do with the weather at any given location on the earth and develop the relationship between humans and water. We propose design suggestions for the future mobile application user interface based on input from our study carried out during the user interface design process.

CSS Concepts
Human-centered computing → Human-Computer Interaction; Mobile Application; User interface programming

Keywords - User interface, User experience, Water Quality Information, Real-time, Mobile Application

1. INTRODUCTION

Despite the fact that water covers 71% of Earth, potable water resources are limited. When it comes to air quality or weather, we can quickly obtain real-time data online or through mobile weather apps, but not for the water we drink.

Although it's likely that the water people drink is secure, scientists have discovered very late that that is not the case. Just a sip of poor-quality water can cause severe health issues. At the Blue CoLab at Pace University's Seidenberg School of Computer Science and Information Systems, which attempts to alter people's perceptions of water, we have collaborated with faculty and students. In this study, we present a design for a Water Information Extension for the iOS Weather mobile phone application that enables users to retrieve real-time information about the quality of water. Several usability factors, such as learnability, efficiency, memorability, mistakes, and satisfaction, are incorporated into our design. This work describes the design and research for the prototype of water information extension for the iOS weather mobile phone application.

2. LITERATURE REVIEW

In [1] A. Ailamaki et al. stated in their paper that using an older database of water-quality traits and a deeper comprehension of the issues in water quality may help us better comprehend the complicated link that is a component of water quality. They concentrate their decision-making studies on vast databases of fictional data. Using data from previously occurring events, the model predictions are contrasted with the historical data. They discussed a wide-ranging research project that combines knowledge discovery in enormous environmental datasets with biological and chemical sensor networks to alter drinking water quality and security decision-making. They provided a distribution and operation protocol for the installation and utilization of in situ environmental sensors by integrating (1) new algorithms for spatial-temporal data mining, (2) new methods to forecast water quality and security dynamics, and (3) a sophisticated decision-analysis framework.

V. Henrique et al. [2] mentioned in their research that utilizing multi-objective ensemble learning to evaluate drinking water quality. The issue is a data set with a significant imbalance ratio, and occurrences, the minority class, must be precisely detected given a time series indicating water quality and operational data on a minute-by-minute basis. The given data set is initially put through a preprocessing stage that includes concept drift correction and the addition of additional statistical characteristics including moving average, moving standard deviation, moving maximum, and moving minimum. Water, according to Mohammad Zakir Hossain in [3], is essential to all life and is utilized for daily tasks like drinking, washing, and cleaning. The

author also mentions how many different faiths and religions view water as a means of purification.

In the article [4], Sudhakar M. Rao et al. discuss how water pollution is slowly rising daily. Given that 70% of the surface of the globe is covered by water, it is concerning that if water pollution continues to rise at this rate, it will not only impact land-based life but also hurt and destroy biodiversity. Since everyone is equally guilty of this pollution, we cannot hold one entity liable for it. Industrial pollution, residential activity pollution, agricultural activity pollution, geological origin pollution, and many more are some of the main sources of water contamination.

According to G. Fred Lee et al. in [5], the EPA has developed water quality criteria in accordance with its mission in PL 92-500, which will act as the basis for state water quality standards. The technical and management community is increasingly opposed to these criteria's direct application as numeric water quality standards, as advised by EPA regulation because they are typically "worst-case" scenarios. The authors discuss what is meant by "water quality," as well as how to establish standards and recommendations for maintaining and enhancing it. When assessing the water's quality, it is important to take into account the desired beneficial applications. Because there are several physical, chemical, and biological factors that influence how a chemical influences water at various locations, water quality standards ought to be developed on a site-specific basis. As per Geoffrey C. Poole et al.in [6], conventional water quality regulations have helped to successfully reduce the number of dangerous substances in US waters. Conventional standards, however, are based on simple thresholds and lack the right framework to address imbalances in dynamic, natural water quality parameters, such as nutrients, silt, and temperature. A more practical type of water quality standard would be a "regime standard," which would outline desirable distributions of conditions over space and time within a stream network. By demanding the maintenance and restoration of the aquatic ecosystem dynamics required to support beneficial uses in streams, well-designed regime requirements would enable more effective techniques for managing natural water quality metrics.

3. METHODS

To make sure that the demands of the end users were considered at every stage, we followed the user-centric design approach.

3.1 Generative Research Approach

Empathizing with the users was the first step in better comprehending the problem domain. This was accomplished using competitor analysis as a secondary research technique and primary research technique as user interviews and online surveys because the theme of the topic is very important and affects people’s day-to-day life directly and indirectly.

a) Competitor Analysis

By analyzing the data using a variety of parameters, we tried to grasp the general vector of the water information services that are currently available. We started the investigation by examining a few similar platforms, examining their user interfaces, user experiences, user flows,

information architectures, and significant features. We found that there are not too many venues available for information on real-time water quality index and related metrics.

Disadvantages of these platforms:

- One should be able to make reviews because the ratings are quite close.
- The visual design is not appealing, that is it is not a modern contemporary design.
- As soon as the app is opened, it can be challenging to navigate through the screens because the landing page doesn't clearly explain what is happening.
- Doesn’t show what the water score is based on.
- Locating particular criteria is difficult.
- It is more challenging to navigate the materials when they are improperly categorized.

b) Stakeholder Interview

Together with the Pace Pleasantville Blue CoLab team, this project was created. A group interview with Prof. Cronin was one of the techniques used to learn more about the specifications of the product and the stakeholder's expectations. This was done in order to understand more about their work as well as how to handle and utilize the team's data collection efforts. The interview was conducted online.

The following topics were discussed at the meeting:

- Vision of water story.
- Importance of water and this project.
- Information about draughts.
- Existing work.

List of the questions asked:

- How do you envision the water story?
- What work is already done and what needs to be started from scratch?
- What do we know about our user's preferences around this product, and likewise, what are we not yet sure about?
- What does success look like for this project?
- What are the potential pitfalls of this project?
- What user need led to this?

c) User Interviews

After meeting with the stakeholder Prof. Cronin from Pace University at Pleasantville, we developed the interview questions and selected five residents of the tri-state area who matched the user profile. We had two virtual interviews in addition to three in person. We made the choice to converse with them in their mother tongues in order to encourage them to be completely honest with us. In order to assess the comments and make notes later, we taped every response given during the interviews. Our objective was to gain a better understanding of the end users.

The questions asked were:

- Before buying food do you check the ingredients? Follow up: have you ever thought of doing the same with water in your house?

- Do you know where the drinking water in your house comes from?
- Do you know how the quality of water at your house can affect you?
- How much does water quality matter to you? Likert Scale- not at all very important (1-5)
- Do you check the water quality before drinking? If so, how?
- Do you prefer drinking Tap water or bottled water or filtered?
- If you prefer drinking tap water, do you filter it before consuming it?
- Which brand of bottled water do you usually buy or prefer using?
- Do you know about the illnesses contaminated water can cause?
- Would you like to receive notifications about the water quality in your vicinity?
- Would you like to see real-time information about water quality on your phone? (weather app example)

d) Online Survey

By sharing an online survey, which acted as a quantitative component of the generative study, we were able to get to know a broader range of people from the target users. Residents of the tri-state area as well as the people we interviewed were asked to take the survey. We received 35 responses in total.

List of the questions asked:

- Where do you mostly get your drinking water from?
- Do you filter your water? If yes, how do you do that?
- Do you prefer drinking Tap water or bottled water or filtered?
- Have you ever thought about the ingredients in the water you drink?
- Do you know what the Water Quality Index (WQI) is?

e) Field Study

In order to understand more about the users, the tasks assigned to them, challenges, and user vocabulary related to the mobile application, we employed usability testing along with adaptive interviews and direct observation methods for the field study of the project. We observed how 6 participants navigated through our app for a period of 5 days. Participants performed the following tasks -

Task 1 - **Find out the ph value of water in New York City**

This task was to find out whether the users can interpret the data provided by the app and can rightly navigate to the different detailed pages of factors affecting WQI.

Task 2 - **Find out the history of the water quality of Pleasantville**

This task was to find out whether the users are able to navigate to the page informing the WQI history of any location.

Task 3 - **Find out the water quality of Pleasantville and explain what it tells you**

This task was to understand if the users can interpret the data provided by the app to check if the water quality in their location was good, moderate, or poor.

Task 4 - **Read the reviews left by other users about the water quality of Pleasantville**
This task to understand if the users understand the 'Write a Review' feature of the prototype and can interact with it.
The participants were also asked to take the SUS (System Usability Scale) questionnaire to rate the prototype's usability.

3.2 Findings

Based on the research that was done, all the data was evaluated to determine which information should be added to the application interface to enhance its functionality.

We advanced toward the solution by analyzing competitors and came up with a list of salient features:

- Possibility to search and add location.
- Water quality index number display and a suggestion bubble if the water is safe to drink based on the WQI number.
- Possibility to show which metrics the WQI number is based on.
- Clean information architecture of the metrics.

In the stakeholder interview, the team discussed the several projects they were working on, how the concept for this particular project came to be, and all the information that had been gathered up to this point. The purpose was to learn more about the Blue CoLab team and their work based on the questions asked. Additionally, we learned about the abilities that each individual member held as well as their ideas for the project. It was important to get different answers to the final question addressing the vital deliverable since it showed us that different people view and think about water in different ways.

Through the user interviews and online survey we learned that the effects of water and how the quality is affected appeared to interest certain people from the health or technology sectors. When it came to the tech section, the majority of people only talked about what they did on their phones or computers, but a few people went into more detail about how their life was centered around technology in general. We wanted to learn general information about the customer so that the mobile application could be tailored to their needs and requirements. These questions were a combination of informal and project-specific inquiries. Most people were unaware of the idea of water quality in general.

During field study we found that 1 out of 6 participants felt that there was too much information on the screen to grasp. 5 out of 6 participants found the prototype attractive and easy to use. 5 out

of 6 participants understood what the ‘Write a Review’ feature was about. All participants could easily interpret the data provided by the app. All participants saw the resemblance of our prototype to the iOS Weather App and hence could easily understand it to be an integration within the iOS Weather App and thus found the app to be very learnable. One of the participants mentioned that she would not use the app everyday. However, if she travels to a new location, she would use the app to check the water quality and make a decision whether to drink tap water or bottled water.

3.3 Information Architecture

We started creating the tools necessary to proceed once we had a general notion of what the structure, look, and feel of our solution would be, i.e. the information architecture - The design structure's blueprint. The objective was to structure and arrange the content for the platform and comprehend how much data would be available during the design and development phases.

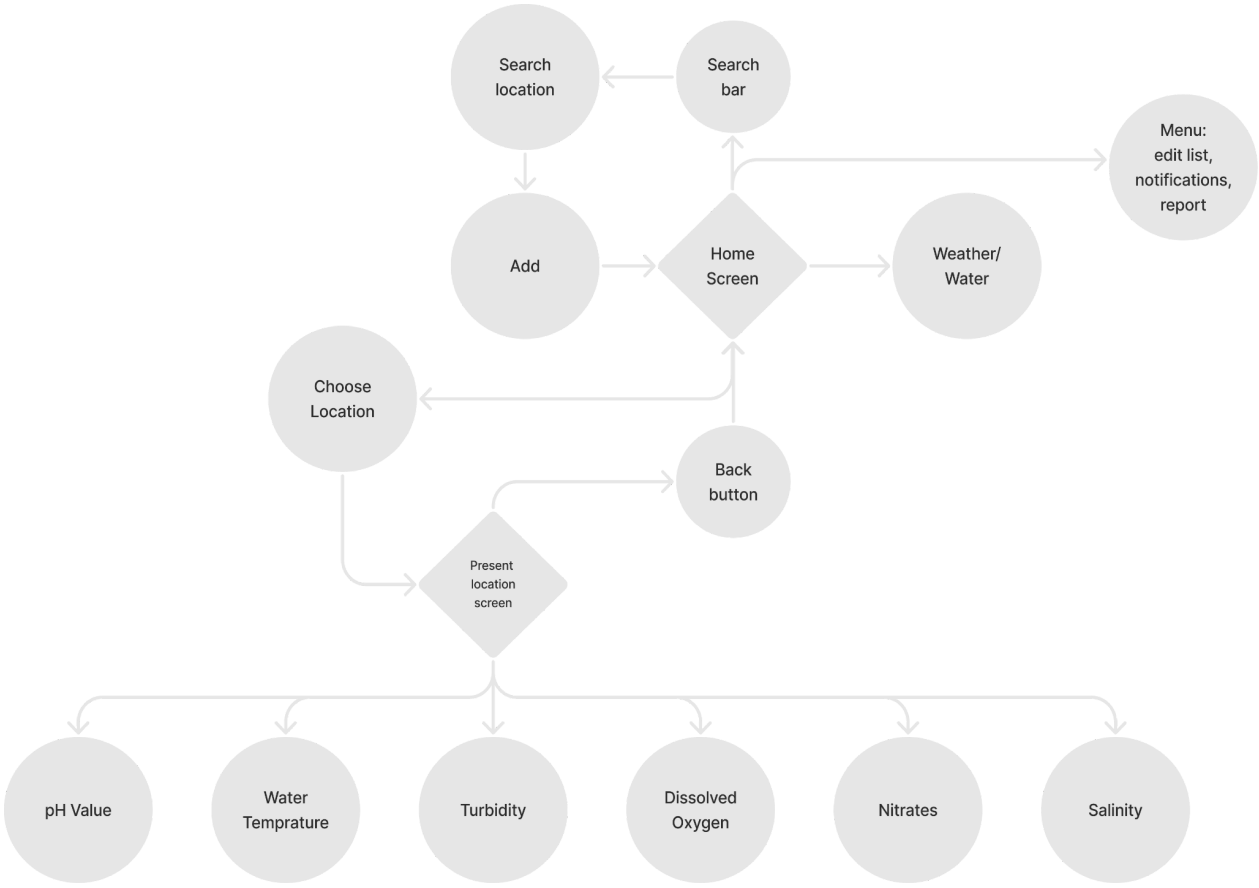

Diagram-1: Information Architecture of the Mobile App

4. OUTCOME

We aimed to develop a user interface based on the user requirements and the insights that were gained from the user interviews, online survey, and usability testing.

4.1 Key Features

The app's many displays were designed to visually represent all of its features in a clear and concise manner. The home screen consists of a search bar for finding a location, real-time water quality information for the saved locations, and information about what the water quality index is as shown in figure - 1. In the Real-time Water Information Screen water quality index of a particular location and all the metrics that affect the overall water quality index of water in that location as shown in figure - 2. The notifications screen will allow the users to see all the notifications about the water in their saved locations as shown in figure - 3.

Figure - 1: Home screen

Figure -2: Water Information Screen

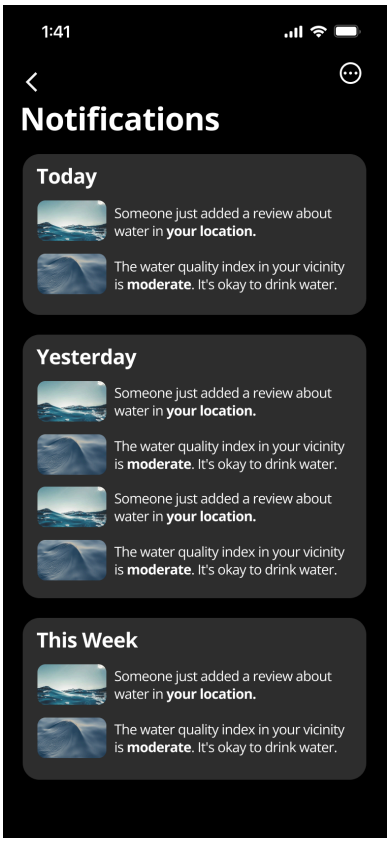

Figure -3: Notifications Screen

4.2 Other features of the App

The water quality history page consists of a graph that depicts the WQI of a particular location for the current and previous years along with information on the primary pollutant of water in that location. It also has a table that gives information about what the WQI values represent and their color codes as shown in figure - 4. The pH Value screen gives information on the pH value of a particular location, what pH means, the causes of high or low pH, and what dangers it might

present as shown in figure - 5. The Real-time Water Information screen shows the WQI of a particular location if it's of good, moderate, or poor quality and the factors that affect the WQI - water temperature, pH value, dissolved oxygen, nitrate levels, turbidity, and salinity. There is a section at the bottom of the screen that can be used by the users to write a review of the water quality at their location and also leave reviews left by others as shown in figure - 6.

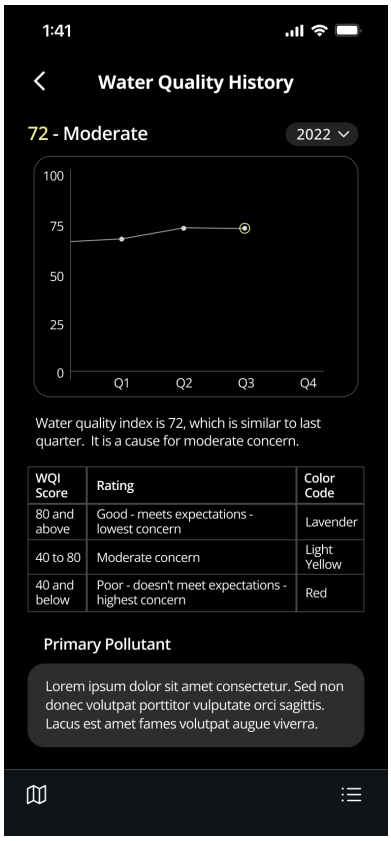

Figure - 4: Water Quality History Screen

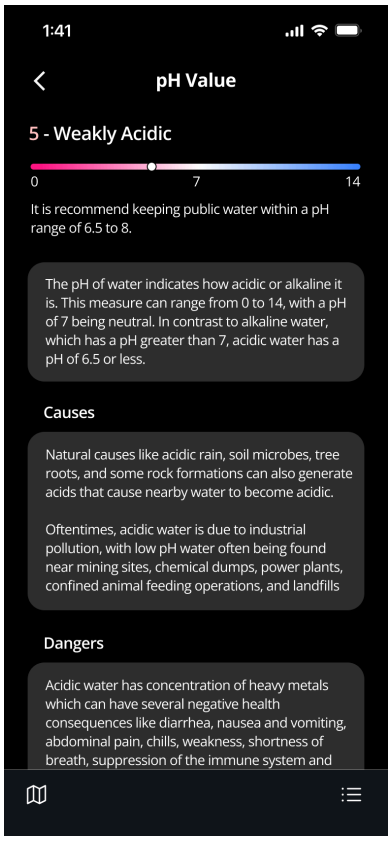

Figure - 5: pH Value Screen

Figure - 6: Water Information Screen

5. LIMITATIONS

This study was carried out to raise users' knowledge of water, subsequently mobile application extension interface design (based on HCI). There were, however, some restrictions. It's possible that there might be some technical problems while managing real-time data with Ada software development. Additionally, the sample size we used was minuscule. We had 35 people complete the survey. There were just six people in the field studying. This study was conducted over a period of four months and hence, there was a time constraint to perform the research.

6. FUTURE WORK

Based on the user evaluation and responses received we have come to the conclusion that the application needs a few improvements in order to serve its purpose. In the future, we want to add information about where and how the users can contact the right authorities to take steps to

improve the water quality in their area. We plan to expand the geographical area of the water along with increasing the number of people participating in the survey and in the field study.

7. CONCLUSION

Water is a precious resource for all Earth's inhabitants. Therefore, it is crucial to continuously monitor the state and quality of the water. In this paper, we proposed a solution to this problem by designing a prototype that informs the users about the quality of water in their area, its primary pollutant and also gives them the opportunity to read and write reviews about their experience with the water in their neighborhood. This solution is an integration within the iOS Weather mobile application which the users can access by switching from the Weather to Water tab provided within the app. Solving a problem does not necessarily mean building a new product. If the same problem can be solved by slightly altering an existing product, then that saves a lot of time and capital. The users can also easily incorporate the solution into their lives if it's through an existing product that they already use. By providing this solution we aim to alert the users about the importance of the quality of water they are consuming and how it might impact them.

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