Gustavo Moreira
Kazi Omar
Shanghao Li
Farah Kamleh
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CS 522 - FSP Deliverable #5 - Report

Introduction:

Our project originated from an identified issue faced by university students with dietary restrictions, particularly those frequenting UIC's United Table in Student Center East. Through a series of six interviews emphasizing the "what, how, and why," we sought to understand the challenges these students encounter while searching for safe food options.

The interviewees, primarily UIC graduate students in Computer Science and related fields, showcased a spectrum of dietary restrictions stemming from religious beliefs to allergies. They highlighted the difficulties in confidently locating safe food options within the university's dining services, emphasizing the inconvenience and lack of essential features in the current interface, accessed through the UIC Dining Services website. The interviews unveiled the need for a more efficient and user-friendly solution. From these insights, the concept of a dedicated mobile app emerged. This app envisions a seamless platform for swift access to essential dining information, aiming to address the identified challenges by incorporating design principles such as efficient solution, discoverability, and mapping.

The subsequent phases involved the development of low-fidelity prototypes, guided by the identified user needs, and the translation of these prototypes into a finalized mobile application during the delivery phase. The technical architecture of our application relies on React Native with Expo CLI, React Components, and local JSON data for dynamic menu retrieval, employing a generative AI tool for dish images, all while avoiding a separate database by locally storing persistent data.

The app evaluation involves a comparative study between our developed mobile application and an existing solution, "Dine on Campus," to address user needs gathered from interviews. Participants, exposed to both apps, perform tasks within the dining hall—identifying foods meeting their dietary restrictions and locating these items within the space. Data collection predominantly focuses on qualitative aspects, gathering estimates for task completion time and screen recording lengths. Additionally, factual details such as meal time and space congestion are noted to contextualize task performance. The study follows a within-subjects design, exposing all six participants to both treatments, aiming to gauge the apps' efficacy in addressing user needs within a real-world dining scenario using Hart and Staveland’s NASA Task Load Index (TLX) for qualitative assessment.

Our journey, sparked by understanding the challenges faced by students with dietary restrictions, evolved into a comprehensive design, implementation, and evaluation process. Our intent was not solely to create an app but to provide a transformative solution, enhancing the dining experience for students navigating dietary restrictions within UIC's dining facilities.

Research:

Our research focused on surveying various academic papers to extract insights that could fortify and ground our solution within existing knowledge domains. While no single paper precisely addressed our project's scope, several key papers provided valuable perspectives relevant to our endeavor.

Food Literacy and Decision Making

The paper "Food Literacy while Shopping: Motivating Informed Food Purchasing Behavior with a Situated Gameful App" underscored the influence of information on food choices and the impact of gamification in fostering informed decisions. Emphasizing pre-planning stages and in-store decision-making, it inspired our approach to integrate planning functionalities akin to MFG and in-store assistance akin to PBGA, promoting informed decision-making within food halls.

Additionally, their use of a top-down supermarket layout for navigation resonates with our aim to simplify navigation tools while enhancing efficiency. Acknowledging the personalized nature of dietary requirements, our app will offer tailored planning options accommodating multiple restrictions and preferences, aligned with the paper's emphasis on personalized dietary planning.

Augmented Reality and Navigation Aids

"Navigation-Based Application with Augmented Reality and Accessibility" elucidated the potential of AR-enabled navigation aids, though not directly applicable to our context due to potential task overload. However, its multimodal interface and A* Pathfinding algorithms inform our intention to employ multi-modal feedback and efficient route calculations based on user meal plans, aligning with our user needs within the selected dining space.

Utilizing audio cues for station visitations and step-by-step guidance, inspired by this study, could enhance user experience without requiring constant physical interaction with the smartphone.

Conversational Recommendation Systems

"Developing a Conversational Recommendation System for Navigating Limited Options" highlighted the efficacy of conversational interfaces in assisting users with nuanced preferences and context-specific requirements. While focusing on restaurant selection, its insights into understanding dietary restrictions from user inputs, scenario-based recommendations, and adaptive conversational strategies are valuable. Our app aims to integrate conversational interfaces, infer user dietary preferences, offer scenario-based recommendations within food halls, and adapt to changing user needs.

Integration of Insights into Solution Design

The amalgamation of these insights into our app design encompasses the utilization of conversational interfaces, personalized dietary planning, efficient route calculations, and emphasis on both pre-planning and in-store decision-making. Our aim is to create a comprehensive solution that not only navigates food halls efficiently but also aids users in making informed dietary choices aligned with their restrictions and preferences.

Requirements:

After conducting a series of interviews with our target users, we not only determined their needs as students with dietary restrictions, but also crafted two user personas representing various diners in need of solutions: the “irregular visitor” and the “regular visitor”. Our first persona, John Doe, is an irregular visitor who, like many of the interviewees, needs his experience of visiting the dining hall to be more organized, as the many stations and food options are overwhelming for an infrequent visitor. As a student who avoids pork, eats halal, and has allergies, John needs an easier way to locate foods that align with his dietary restrictions and preferences. Lastly, he would greatly benefit from self-reliance when navigating the space, as he currently has to constantly locate workers for assistance who, in many cases, unfortunately cannot help.

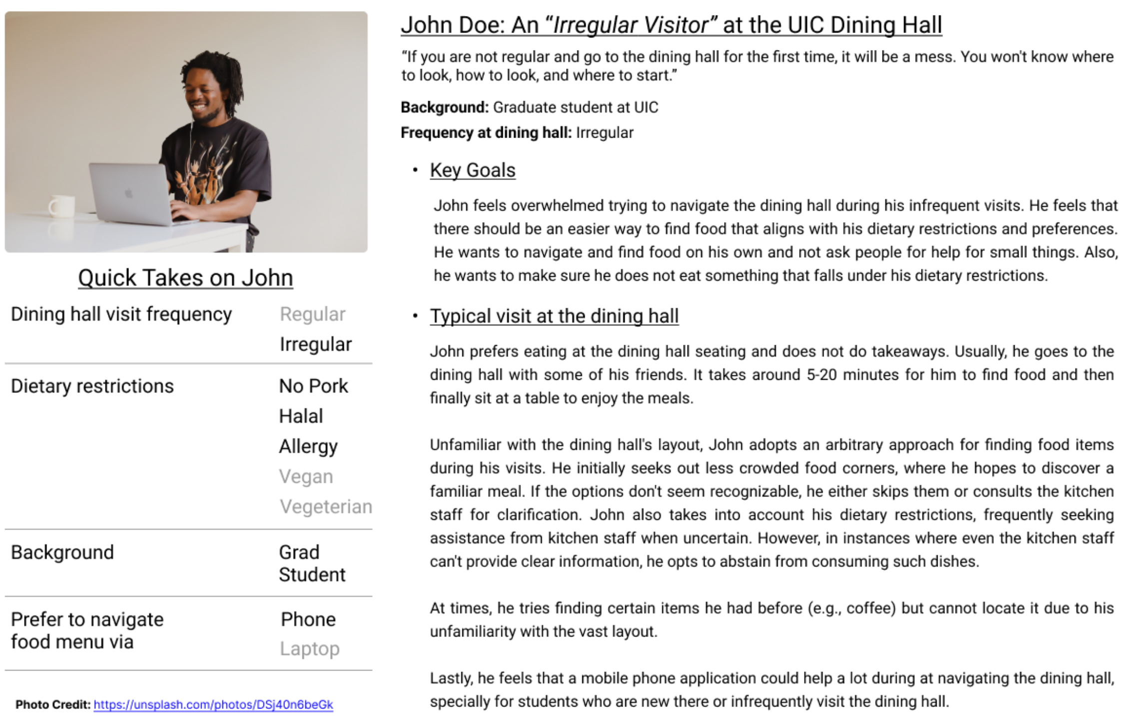

Figure 1. The “irregular visitor” persona derived from initial findings (John Doe).

The second persona, Jane Doe, represents the “regular visitors” among our interviewees. She is especially interested in convenience, as she would like to locate foods that fall within her diet on the menu as quickly and efficiently as possible. In her case, she would like to easily avoid spicy foods and, like John, those that contain pork. She would also appreciate ease when attempting to map the name of a food on the menu to the way that it looks in the space. Similarly, she would also like more time to read the displays that showcase the food options, as they switch screens far too quickly. Conversely, one of her needs is spending less time acquiring food and more time eating food. Finally, she wants to receive clear answers rather than relying on the limited knowledge of the workers.

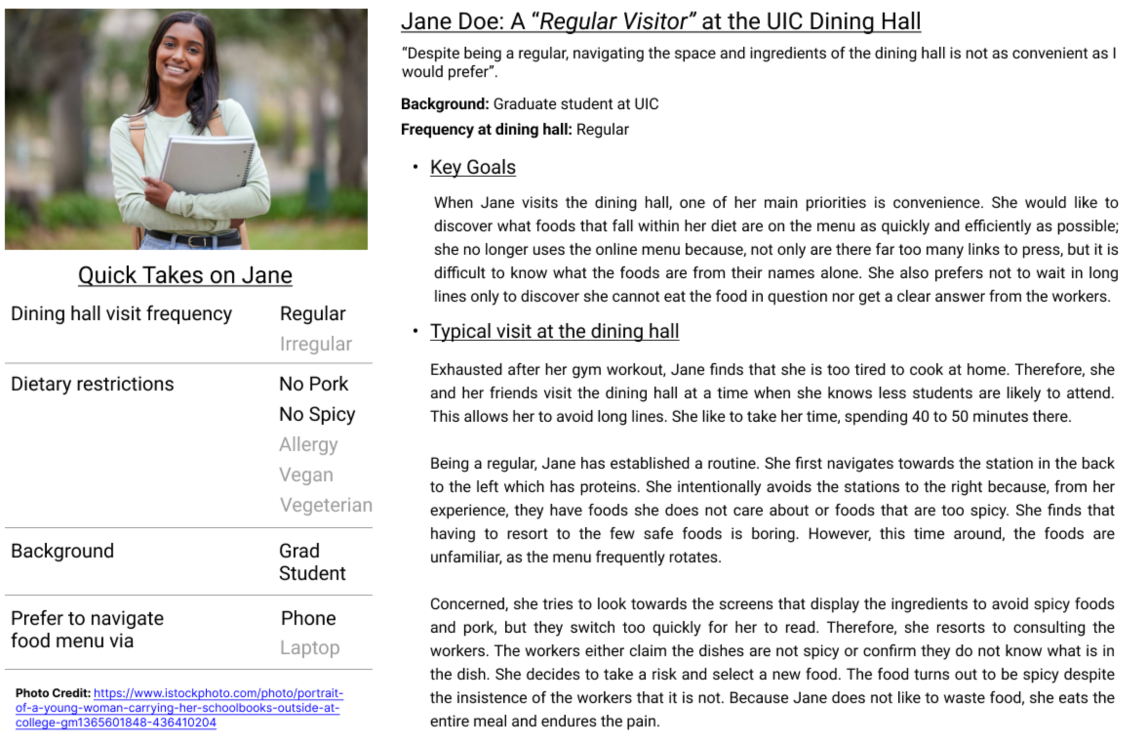

Figure 2. The "regular visitor" persona derived from the initial findings (Jane Doe).

Ideation:

Our mobile application, the Efficient Food Hall Navigator, aims to address the multifaceted needs of users navigating food halls while considering dietary restrictions. The app's development is guided by the primary objective of prioritizing user-centric design principles, ensuring an intuitive and personalized experience for users with dietary preferences or restrictions.

Central to our app's functionality is the incorporation of User Profiles, enabling users to create detailed profiles outlining their dietary restrictions, preferences, and allergies. The inclusivity of various dietary restrictions such as gluten-free, vegan, vegetarian, lactose-intolerant, or specific medical conditions like diabetes or celiac disease ensures a personalized and tailored experience for each user.

Moreover, the app will offer a Meal Planning feature, empowering users to plan their meals for the day within the app. This functionality is designed to provide personalized food recommendations based on user preferences and dietary restrictions. By curating meal plans aligned with individual preferences, the app seeks to streamline the dining hall experience.

The insights gleaned from client interviews laid the foundation for crucial features and functionalities of the app. Notably, participants highlighted the need for a better means to navigate dining hall menus, suggesting features like saving favorite items, checking food availability on different days, and receiving notifications for the availability of preferred food items.

Key user concerns, such as accessing detailed ingredient and dietary information, navigating the dining hall efficiently, and addressing allergen awareness, significantly influenced our app's design. The emphasis on a well-structured menu, clear food labels, and efficient navigation tools is a direct response to the challenges articulated during client interviews.

Finally, we aimed to create a mobile app that not only addresses the current limitations of the **UIC Dining Services Website** but also leverages design principles and insights from relevant literature to revolutionize the dining experience for students with dietary restrictions.

Prototype:

Given the user needs extracted from our need-finding activities, we grouped them into two general groups, as we mentioned before: regular and irregular dining hall visitors.

We brainstormed screens and functionalities that support one of both personas' needs. Keeping the fundamental premises of the application in place (map, menu, and navigation), the brainstorming sessions presented paths for designing the interface to fulfill the needs of our users.

For prototypes, we designed a screen offering options to configure the user profile with dietary restrictions. After selecting dietary restrictions, we sketched a screen displaying a recommended plan based on the user's dietary restrictions. These two screens serve the common user need of both personas: the ability to discover food options aligning with their dietary restrictions. We also created a map layout screen for efficient navigation of the dining hall. This serves the user needs of both our personas on navigating the space rather than relying on workers. Lastly, we sketched a screen where the user clicks on a food item on the recommended food plan screen, they can access its ingredient list. This serves the user needs of regular visitors by reassuring them of their food preferences with its nutritional info and not asking the dining hall workers for it. These sketches are displayed in Figure 3.

Figure 3. Selected sketches for low-fidelity prototype.

In the process, we excluded designs that introduced unnecessary complexity and did not align with key user needs. For instance, we thought of having a screen that introduces users to the app through a tutorial. If the user is familiar with the app, they could skip it. However, this did not directly address any key user need, and thus, we later scrapped the idea. Also, we had the idea of adding a screen where users can leave comments about food items or ask/answer questions. Later, this was also discarded. These sketches are illustrated in Figure 4.

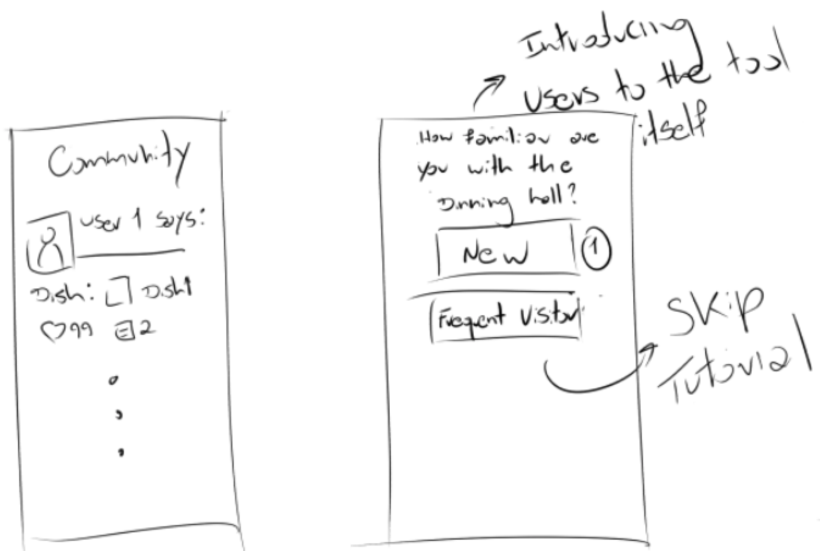

Figure 4. Discarded sketches for low-fidelity prototype.

Delivery:

Design Prototype

After having created low-fidelity prototypes, the next step was to create Figma prototypes while keeping in mind the needs of our target users. In order to cater to their need of finding food that falls within their dietary restrictions, we designed a page in which they can disclose their dietary restrictions, resulting in a filtered list of recommended foods for a specific day. They can then select food items from the recommended meal plan that is tailored to their pre-defined restrictions.

Subsequently, the user can generate an optimal route by pressing the “Generate Best Route” button at the top of the screen to efficiently locate the food items they have chosen within the space. This functionality addresses the shared need of both user personas to efficiently and effectively identify food items as well as navigating the space independently rather than relying on workers. In addition, for greater self-reliance, the user can locate the ingredient list for each item of interest.

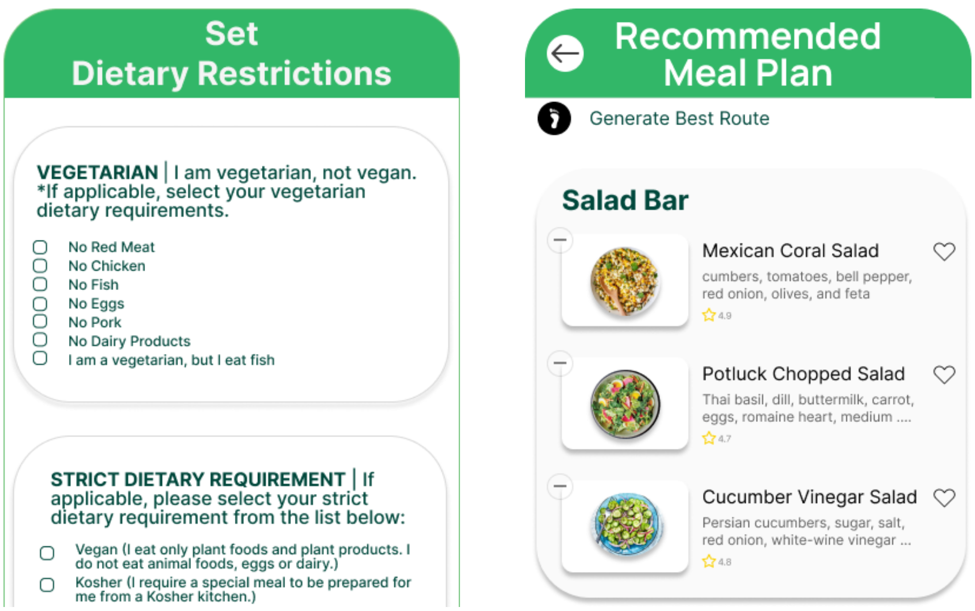

Figure 5. The Set Dietary Restrictions (left) and Recommended Meal Plan (right) pages.

After the user has finalized their meal plan, they are directed to a map of the dining hall which is labeled with numbers on various kitchen counters. The numbers are indicative of the optimal route for gathering the selected food items as efficiently as possible. By selecting one of the numbers, the user can also access the list of food items located at that counter that need to be collected. The map page serves the users’ need of efficiently finding food items in the dining hall.

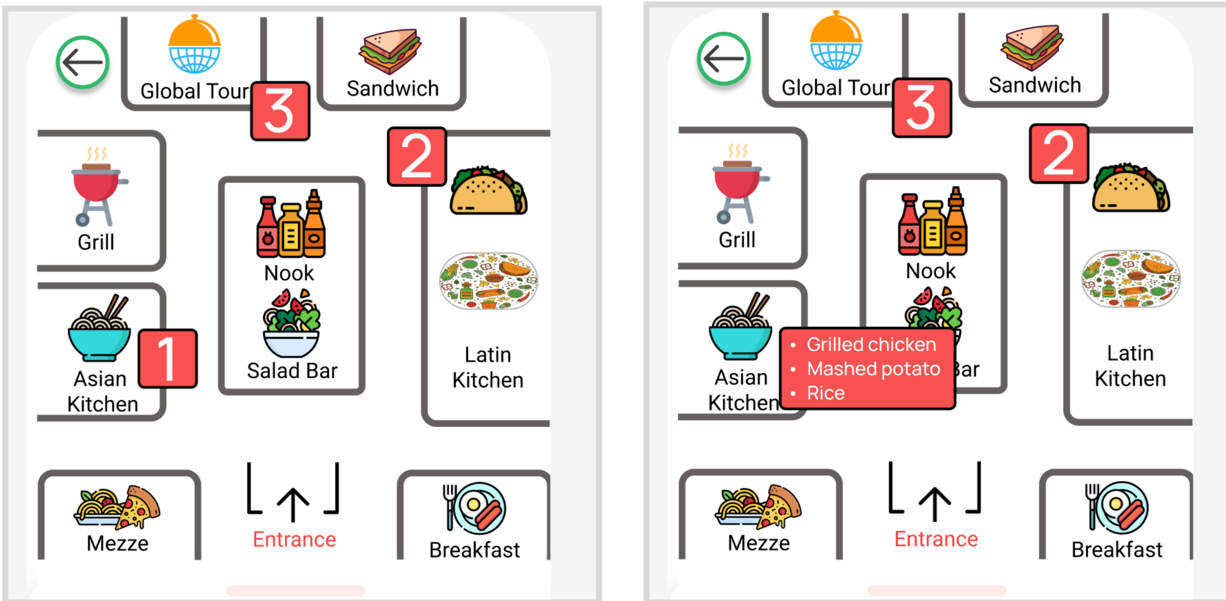

Figure 6. A map of the dining hall labeled with numbers indicative of the best route.

Implementation

To further progress the application based on the prototypes developed and feedback from testers, the next step was to build the application using React Native and Expo CLI for an expedited development and testing cycle. React Native served as the primary network, enabling cross-platform compatibility for iOS and Android. Expo Go was utilized as the testing platform, providing a convenient way to preview and test the application on physical devices.

The architectural components of the application utilized React Components — DishCard.js and PlanCard.js — for multiple screens and reusable UI elements, React Navigation for seamless navigation between the different pages, and local JSON data — RestrictionQuestion — for the quiz questions and options. State management relied on React Hooks — useState and useEffect — to ensure that the handling of component-level states is efficient.

To achieve styling, inline styles were used while predefined constants for colors and sizes maintained design consistency across the screens. The data flow initiates with Expo CLI's initialization, followed by component rendering, user interaction triggering state changes, and navigation facilitated by React Navigation. The architectural implementation of the application aimed for compatibility, modularity, and streamlined development; this was achieved through Expo Go which allowed for swift testing and deployment.

To scrape the daily menu, requests are made to a public API exposed by the UIC United Table website. When a user provides the day and the restaurant, the API returns a JSON object containing all the food options categorized by the station and dietary labels. A parser — built by use — is then used to extract relevant information for our application and display said information using React components.

To display the images on the menu, they were first manually collected from Google images. While they are not accurate to how the food items may appear in the space, they provide the user with an understanding of what the food might look like relatively. Additionally, a generative A! Tool — stable diffusion — was used in order to create any missing images. The food titles of the day were used as the prompts for the model.

In the final version of the system, all the persistent data such as the images were stored locally; in other words, no databases were used. All the data concerning the dishes, however, were fetched on demand, as that data changes every day.

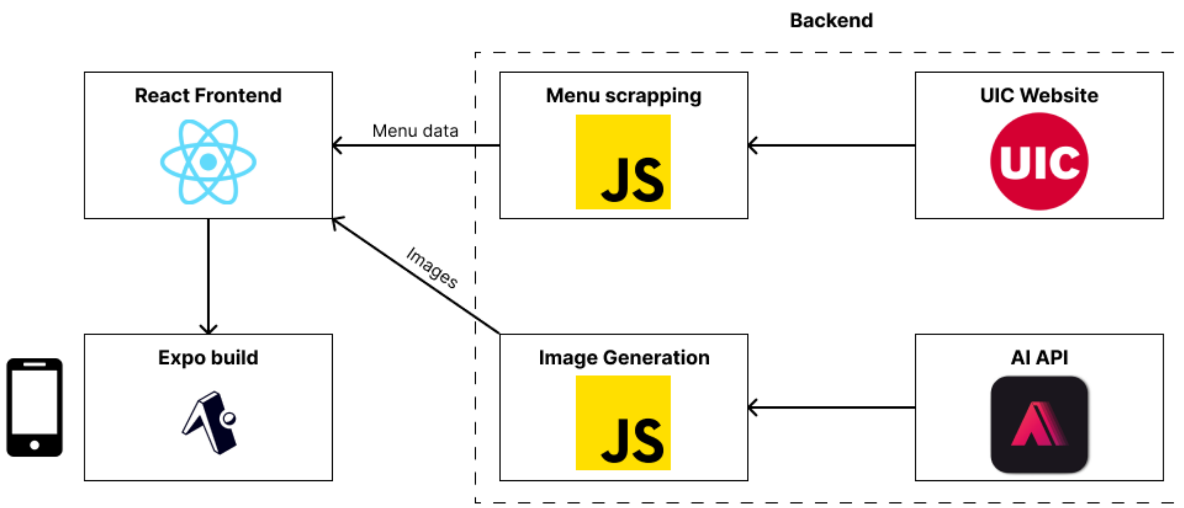

Figure 7. A diagram of the frontend and backend of the interface and how the information flows across.

Evaluation and Analysis:

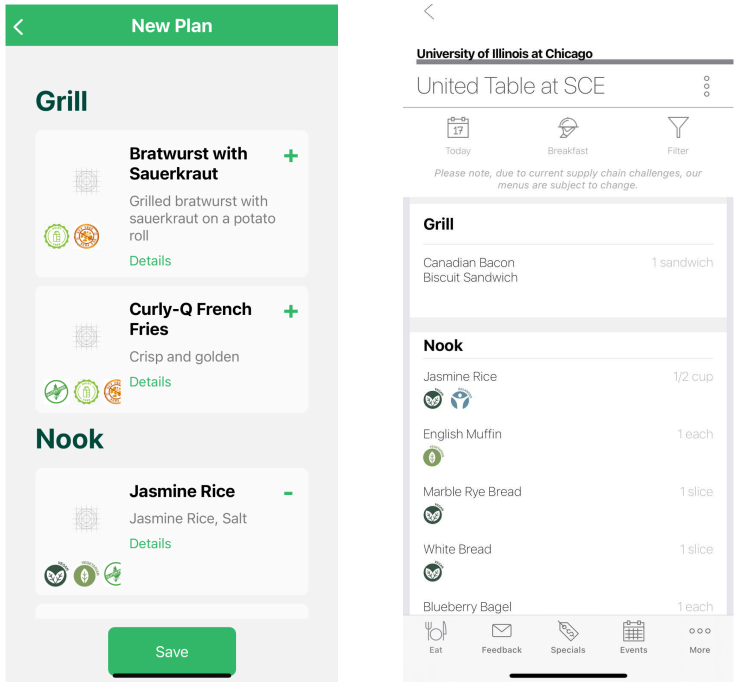

Figure 8. Treatments used in the user study. On the left our proposed design and the Dine on Campus application on the right.

After researching, creating the requirements based on user needs and personas, developing a prototype and a final interface, the last step is evaluating our final design. To do that two different treatments were compared (Figure 8): the mobile application our team developed and the mobile application called "Dine on Campus". The main differences between our approach and the standard is the types of tasks we support. Beyond having a menu to consult, our solution offers ways of building meal plans and actualizing them in the real world with guided navigation.

The idea is to expose a number of users (6 in total) to the treatments to directly and indirectly collect information that can help in the evaluation of our approach. Moreover, the user study tasks to be performed are those that address the user needs gathered from interviews with the mobile application's target users. The first task is for users to discover foods on the menu that fall within their dietary restrictions and add them to their meal plan. The second task is for users to locate the foods listed in their plan within the dining hall space. The intention is for the participants to use the application practically, so they will be performing the tasks inside the dining hall as they would in a real-world scenario.

Data collection

The majority of data collected is qualitative rather than quantitative. Users provided estimates for how long each task took in order to complete as well as the length of their screen recording. According to the interviewees, they are interested in spending less time locating food and more time consuming food, so the time it takes to do so within a busy space is an important measure of each treatment's success. Additionally, factual information was also collected, as it is important to note which meal of the day they are visiting for and how crowded the space is during their visit; these factors could greatly affect their ability to perform their tasks and, as a result, the data collected. To collect qualitative data, the evaluation study used Hart and Staveland's NASA Task Load Index (TLX) method to assess the tasks using scales labeled from Very Low to Very High.

Study type

The study type followed a within-subjects design, exposing all six participants to both treatments. Because evaluating learnability is not the end goal and the tools have a distinct enough approach to the tasks, the same user can be exposed to both treatments for the evaluation study.

It is also important to highlight that, as mentioned before, we are only collecting data after the event, following a post-event protocol. Because users were asked to go to the dining space, we decided to not be present, given the possibility to pressure the participants and bias the results.

Data and Hypothesis

After each session users were asked to fill out the form. The first eight questions were created by us and aimed to understand the general dining experience of our participants. For example, "How crowded was the place during your visit?" and "How much time did it take for you to decide what to eat using the app?". As mentioned before, the second half consisted of questions for task load assessment following Hart and Staveland's NASA Task Load Index (TLX). Additionally, we also asked open-ended questions about their experience to get more spontaneous feedback.

All data is available here:
https://docs.google.com/spreadsheets/d/1ExNYbGtGh6TNuo6QqYbozlMCdm90SlarFLqSeuc2nKU/edit?usp=sharing

The google forms can be found here:
https://forms.gle/kWpNXsNq5DUT8VXC9

Out of the data collected, we can start by highlighting the comments made by the participants. Regarding the "Dine on Campus" application all comments had negative connotations: lack of photos, difficulty to navigate and difficulty understanding what foods were vegan, are some examples. On the other hand, our solution mainly received positive feedback and suggestions of features: adding filtering in the planning section and adding custom dietary restrictions are some examples. One of the users expressed how the application helped him find a new dish he enjoyed.

Statistical Tests and Interpretations

The statistical analysis of the data consisted in the calculation of the average, standard deviation and t-test score for each question of the task load assessment questionnaire. These questions were chosen because they allow a direct comparison between both treatments and the answers can be interpreted as interval variables from 0 to 10. The statistics were calculated by question instead of a unified task load index to help with the explainability of the results.

Question	Average	Standard Deviation	T-Test ($\alpha = 0.05$)
How successful were you in accomplishing what you were asked to do?	UIC: 5.67 Ours: 2.67	UIC: 3.67 Ours: 2.73	0.14
How physically demanding were the tasks?	UIC: 4.33 Ours: 1.50	UIC: 3.39 Ours: 0.84	0.10
How mentally demanding were the tasks?	UIC: 4.33 Ours: 1.83	UIC: 3.32 Ours: 1.17	0.13
How much time did it take for you to navigate the space and get what you wanted to eat?	UIC: 2.5 Ours: 1.5	UIC: 1.33 Ours: 0.52	0.07
How insecure, discouraged, irritated, stressed, and annoyed were you?	UIC: 5.33 Ours: 2.33	UIC: 3.67 Ours: 2.16	0.12

Table 1. Statistical Analysis of the collected data

Table 1 summarizes the most relevant findings regarding the statistical analysis of the data. It is important to note that comparatively the proposed approach got better results than the other treatment in all questions. For the t-tests the null and alternative hypotheses concern the average score for each question. If there is a significant difference between the averages, the null hypothesis can be rejected. Even though (assuming an alpha of 0.05) none of the t-tests supports the rejection of the null hypothesis, many of them get close to it.

Out of the presented questions the results for “How much time did it take for you to navigate the space and get what you wanted to eat?” and “How insecure, discouraged, irritated, stressed, and annoyed were you?”, confirm what was found during user needs evaluation. The subject perception of efficiency and emotional stability are very relevant to the tasks we are tackling.

Our team believes that we are not able to reject the null hypothesis given some small design issues that were highlighted in the participant's comments and in the recordings we took. In the recordings it is possible to notice that users had problems understanding the map tooltips that show the dishes for each isle, to understand the use of the favorites functionality (currently presenting artificial data), to detect the existence of some buttons, and finally to deal with the dietary restrictions quiz that did not allow corrections.

In general terms the main takeaways of our analysis is twofold. First, about the importance of mapping and transposing the digital world to the physical, especially if the application is tied to real objects. In our case, the pictures of the dishes were a great support to that. Second, navigation is not only about helping people to find certain places, but can also be closely tied to mapping and decision making processes of creating visiting plans for instance.

Based on the evaluation we can also reflect on future work in practical terms. Users currently can fetch daily menus with images, display ingredients and nutritional information about the dishes, add meals to plans and locate stations, and navigate the physical space. However, some challenges are still to be tackled: it is still not possible to select any dietary restriction, images do not match exactly with how they appear in the physical space and quality of life interactions and bugs need to be addressed.

Conclusion:

This document presents the design process involved in creating a solution for the challenge: how to "support university students with dietary restrictions efficiently navigate food halls' menus and physical spaces"?. By following an user-centric and formalized approach to the design process we were able to provide a solution that attended to the main user needs and improved the current user experience.

The whole design process can be summarized in the following steps: surveying existing solutions, extracting requirements from users through semi-structured interviews, brainstorming and sketching out ideas based on the requirements, creating low-fidelity prototypes, implementing a usable version of the solution and, finally, going back to the user to get final feedbacks about the system.

Collaboration Record

Student Name: _Gustavo Moreira
Contribution: 1) Helped setting up google forms for the survey. 2) Conducted analysis of the data. 3) Created slides for the analysis of data. 4) Wrote the evaluation and analysis section of the report. 5) Wrote the conclusion for the report.

Student Name: _Kazi Omar____

Contribution: 1) Helped design survey questions for evaluation study, 2) Recruited participants for evaluation study and collected survey responses and videos from them, 3) Created slides for design alternatives and low fidelity prototypes, 4) Wrote ideation and prototype section of the report, and 5) created the 5-minute video.

Student Name: _Shanghao Li___
Contribution: modified survey questions for evaluation study. finished the introduction and research part in the report.

Student Name: _Farah Kamleh__
Contribution: For the report, completed the Requirements and Delivery sections. For the presentation, created the video demonstration of the interface and the Reflection and Future Work section. In addition, communicated evaluation plan through the completion of FSP Deliverable #4.