Designing and Implementing a Personalized Food Recipe Platform for University Students using Web Data Extraction

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Abstract

University students face a variety of difficulties throughout their university life which may prevent them from cooking. Therefore, a viable solution could be created that would help university students to make cooking easier yet interactive using web data extraction techniques. With large amounts of data available on the Internet, web data extraction, or web scraping could be used to collect food recipes to create a food recipe website targeted for university students. During the project process, literature review was firstly researched on a large variety of topics. Requirements from University of Edinburgh students were gathered to understand their perspectives. The design sketch prototypes for the website were developed. I created the static and dynamic designs for the website along with creating two iterations of the food recipe website implementation. Finally, my website was evaluated by University of Edinburgh students. The overall feedback was positive and many students showed interest in using my website when available to the public.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics committee.
Ethics application number: 2019/11901
Date when approval was obtained: 2021-11-09
The project required human participants. The participants' corresponding information sheets and consent forms are included in the appendix.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Justin Howe*)

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The following project would not have been possible without the support of all the participants in my studies. I would also like to sincerely express my gratitude to my supervisors, Cristina Alexandru and Valentina Andries for their sincere support and genuine feedback throughout the whole project. They both have encouraged and challenged me to continuously improve the project. I would also like to express personal tutor Aurora Constantin for giving me the opportunity to self-propose this project for my honours project. I would like to thank my family and friends for their moral support.

On a more personal note, the number of times I have been ignored by others throughout my whole life, whether it be personal situations or the hundreds of Software Engineer internship/graduate job application rejections I received in the past three years, have made me become more mentally resilient than I ever was in my past. Thank you to all of those who have helped and comforted me during my most challenging times.

"Tough times don't last but tough people do." - Robert H. Schuller

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Chapter 1

Introduction

1.1 Motivation

University students face a variety of challenges throughout their university life which may prevent them from cooking. This may include multiple deadlines looming while juggling other responsibilities, such as keeping fit and maintaining friendships. Therefore, students perceive cooking and eating healthily as a rather complicated and time consuming process, let alone spend time and effort deciding what to cook [1]. With time constraints comes with the increased consumption of unhealthy convenience meals and ultra-processed foods worldwide, cooking is not recognized as necessary to satisfy students' daily dietary needs [2]. The lack of culinary knowledge and skills hinder from students from cooking more frequently [3]. Students are not only constrained to the previous factors, students' financial situations are strained. According to the UK 2021 National Student Money survey, about 76% of students emphasized they are struggling with money problems [4]. This would therefore result in having less money to spend on cooking healthily. All of the previous factors mentioned have contributed significantly to the decline of the time spent cooking [2]. Therefore, we want to create a viable solution that would help busy university students to make cooking easier yet interactive using web data extraction techniques.

With a large amount of data available on the Internet, challenges still remain in collecting and analyzing such information. This problem could be solved using web data extraction, or web scraping [5]. With various applications such as the analysis of technical and legal documentation texts, and prediction of social media behavior [6], web data extraction could be additionally used to collect food recipes to ultimately create a food recipe website targeted for university students.

1.2 Aims and Research Questions

The aim of this project is to use web data extraction techniques, particularly web scraping to build an online food recipe website targeted for university students in order to ultimately make cooking easier for themselves.

This aim can be broken down into the following research questions:

1. Regarding University Students:
    - What factors affect students' cooking perceptions?
    - Why are students hesitant to cook?
2. What online and offline resources do students use to cook food recipes?
3. What aspects do students like and dislike about online food recipe sources?
4. What features and improvements would university students appreciate in a food recipe website?
5. How should a food recipe website targeted for university students be designed?
6. How should a food recipe website targeted for university students be implemented?
7. What are the students' perceptions about the developed system with regards to:
    (a) usability?
    (b) potential impact on their cooking habits, in general and compared to existing food recipe websites?

1.3 Dissertation Structure

The dissertation is divided into seven chapters and the structure is clearly showcased. In **Background Knowledge** chapter, a literature review on university students and their perceptions of healthy eating and cooking is conducted. This chapter also analyzes existing food recipe websites and the major technology concepts for the website implementation. In **Methodology** chapter, the methodology explains how the project is executed. In **Requirements Gathering** chapter, the requirements gathering process is justified. Obtaining answers on what university students particularly want in a food recipe website for them. This includes how the questionnaire and design workshops are conducted. The results for those studies are described. **Design** chapter explains and justifies the server architecture, UML diagrams and user interface design prototypes. The **Implementation** chapter justifies the technologies selected for the food recipe website implementation. This includes how my architectural design would meet the students' needs. In addition, the two implementation phases are explained - including how the web application functions and looks. **Evaluation** chapter explains and justifies the two evaluation iterations. Finally, **Discussions, Future Work and Conclusions** chapter summarizes the project and what further action could be taken. The final answers to the research questions and objectives are stated.

Chapter 2

Background Knowledge

Understanding university students' perceptions of healthy eating, cultural influences and barriers to cooking would help one understand why university students may not integrate cooking in their lives. After reviewing literature on thus topic, we then compare and contrast the existing web technology for food recipe websites and explain further on what could be improved. I additionally conducted literature review on the data collection & analysis methods and tools, interaction design and its heuristics, usability evaluation methods and the software development process.

2.1 Healthy Eating

The World Health Organization (WHO)'s definition of "Healthy Eating" contains many guidelines of obtaining a balanced diet [7]. This generally includes eating relative greater quantity of whole grains and vegetables with foods containing high amounts of sugars and salt should be consumed less. The WHO has also published specific guidelines to further define "healthy eating" [7]. Such guidelines include obtaining 400 grams (approximately five portions) of fruits and vegetables and less than 5 grams of salt per day [7]. Furthermore, obtaining foods containing protein, particularly two portions of fish per week would be beneficial [8]. A "healthy diet" additionally includes limitation of free sugars, or non-natural processed sugars [8]. Interestingly not all fats are treated equally, where trans-fat intake is particularly viewed in a negative light compared to saturated-fat consumption [7]. The National Health System (NHS) has recommended adult males to have approximately 2500 calories a day and adult women to have approximately 2000 calories a day, as many adults are consuming too many calories [8].

2.2 University Students and Healthy Eating

To further understand why many university students' diets fail to align with the WHO's recommendations of "healthy eating" worldwide, we reviewed literature regarding how students fail to comply to the following "healthy eating" standards stated above.

University students are reported to consume high volumes of snacks and convenience foods and inadequate amounts of fruits and vegetables in particular [9]. Such snack and convenience foods contain a high amount of calories, it should be noted that approximately 20% of Polish students and an astonishing 46% of students in the U.S. consume fast food as a main source of nourishment at least twice a week [9]. Many students' diets lack the following fruit and vegetable intake suggestion. Research has shown university students in the UK only daily consume an average range of 2.2 to 3.8 portions of fruit and vegetables [9]. The estimated range of students meeting the standard ranges from 3.27% to 34.7% [9], failing to meet the five portions of fruit and vegetable consumption standard [Background - 2.1]. In addition, only approximately between 3.2 and 3.6% of German university students consume raw and cooked vegetables several times a day [10]. On the other hand, the average consumption of processed food and additional sugars is higher than the recommended intake. For example, in a given survey sample of 689 German university students, about 80% of them state they eat chocolate at least once a week [10].

Students' perceptions of understanding the benefits of eating healthily and actually practicing eating healthily may differ [11]. While the majority of this generation of students seem to understand the importance of healthy eating and the negative long term consequences of eating unhealthily better than previous generations, there are many factors why students choose to eat unhealthily due to barriers to cooking stated in Section 2.4 [11]. The perceptions of healthy eating also raises another question - whether cooking correlates to eating healthily. Using the Healthy Eating Index which measures diet qualities to assess how well a food set aligns with the USDA dietary requirements - the higher the score index, the higher the overall diet quality. According to a University of Michigan study, individuals with lower income scored 52.51 points where as individuals with higher income scored 57.35 points based on the HEI-2015 measure [12]. Even though frequent cooking correlates to a higher Healthy Eating Index, the question remains how university students, especially those with lower income, can still eat healthily.

2.3 Cultural Influences on Students' Perceptions of Cooking

Cultural influences, such as family and friends, can positively impact an individual's perception of cooking [13]. University students tend to cook more when eating together view this activity as a form of social bonding [13]. In addition, familial ties can influence a university student's decision to cook. If the mother cooks food, it shows a form of obtaining independence, which therefore encourages the student to cook [11]. To further emphasize this point, previous studies have concluded that eating healthily with friends influence them to choose more healthy food options [13]. Besides family and friends, the effect of social media and television can influence the way university students eat due to perceived notions of how a young adult should look like [11].

2.4 Students' Barriers to Cooking

Many university students lack substantial financial support, leaving them little money for cooking. Almost half of Newcastle University students believe they lack sufficient financial resources which covers their university fees, housing and living [14]. Given the Covid-19 pandemic, more university students are financially strained due to increasing tuition fees and rent along with less financial support from national governments. According to a national survey conducted by The Guardian, the average student has paid 1,621 pounds in unused rent accommodation with no form of refund [15]. With payments to universities and rent, students struggle with other matters including feeding themselves.

Besides lack of financial support, lack of time also remains as a common theme which strongly concern university students. Approximately between 33-50% of U.S. students located in the Midwest have difficulty in finding time to eat regularly scheduled meals and shop for food [16]. 62.6% of German university students agree that a lack of time due to university commitments along with other expectations remain a barrier to cooking more [10]. Besides juggling with academic commitments, students often struggle with other commitments not limited to paid work and other responsibilities. Given a sample of 1200 community college and university students in the Midwest, approximately 68% worked for pay [16].

Students' perceptions of understanding the benefits of eating healthily and actually practicing eating healthily may differ [11] due to various factors. While university students acknowledge the importance of eating healthily, but few actually regularly do so [16]. A study sample of between about 37% to 46% of UK university students claimed that time constraints contribute to their poor dietary habits [16]. Some students mentioned that benefits of the time-saving and convenience attributes of unhealthy junk food outweigh the benefits the time-consuming activity of cooking and eating together [11]. Time is not the only significant contributor to the poor eating practice. The perceived high costs of buying healthy foods contributes to the factor of eating unhealthily [11]. Some students also lack the culinary experience and skills to cook nutritious meals for themselves [11], which would likely result in them relying on other sources to nourish themselves. According to a study conducted by multiple UK universities, approximately 45% of a sample of 1448 students reported limited or non-existent cooking ability [17].

2.5 Meal-kits: A Plausible yet Flawed Solution?

Given the barriers of cooking and eating healthily, delivered meal-kits is an option on how university students nourish themselves. Covering 1% of the UK's online food grocery market and 7% of individuals having attempted meal-kit delivery [18], they attempt to establish a new definition of eating healthy and cooking for the time-poor consumer. Acknowledging that time is an increasingly commodity in today's world, companies including Gousto and HelloFresh, discourage the idea of "unnecessary labor" - thinking, planning and grocery shopping [18]. In addition, the detailed step-by-step approach encourages consumers who lack in culinary skills to cook more [18]. This

approach reduces the dependencies of unhealthy fast-food while promoting healthier eating.

However there exists various concerns regarding this approach. The meal-kit delivery creates major environment impact concerns. For example, Blue Apron - a meal-kit delivery service, delivers their food ingredients fresh bundled together with heavily packaged ice-bags to their consumers. Blue Apron's ice-bag packaging is responsible for producing approximately 192,000 tons of trash from the disposable ice-bags per year [19]. The generation of additional wastage including plastic bags, boxes along with the ice-bag packaging negatively impact the environment [19].

Other negative aspects of meal-kit delivery creates the disruption of the food supply chain. The lack of the alternative sources such as local markets and farmers' markets which encourage a direct connection between the consumers and producers are removed from the food supply chain [18]. In addition, meal-kit delivery service raises labor issues, especially Blue Apron's employees are estimated to be paid about $12 an hour - close to minimal wage [19]. Literature review conducted has not shown the extensive statistics behind the cost analysis of each meal-kit delivery but some viewed the price tags for the service to be hefty, ranging from USD$50 to $80 [19]. This perhaps may suggest consumers would still find cheaper alternatives to find nourishment elsewhere.

2.6 Existing Food Recipe Websites

Given the flaws of the meal-kit delivery service, it raises awareness to another possible solution of how university students can feed themselves healthily and at a reasonable price - food recipe websites. While a large variety of food recipe websites, especially targeted for university students, do exist on the Internet, there is no existing formal literature review regarding food recipe websites targeted for university students has been conducted yet.

The **BBCGoodFood** website [20] is a popular choice for finding food recipes which is used by many University of Edinburgh students [Requirements Gathering - 4.7]. As an acclaimed platform, the website contains tens of thousands of recipes in its database [20]. With many recipes, the website is well-organized where recipes are categorized into multiple categories. Such categories include *"Cheap Eats"* and *"Seasonal Eats"*. The website a powerful search filter engine, where it can filter recipes such as the number of calories and total cooking time. The search engine additionally allows the user to sort recipes based on popularity or total cooking time. Regarding the template for each recipe, each recipe contains well-recorded details including the dietary requirements, recipe difficulty, and total cooking time. Nutrition information is provided for the majority of recipes, such as number of calories in each serving. In addition, the recipe contains the list of ingredients and methods to make the recipe. Each recipe contains the overall rating and users are allowed to comment regarding the recipe. Some recipes are accompanied with videos to illustrate how the recipe should be prepared. Each recipe contains a section called *"Goes Well With"* where recipe recommendations are listed.

Tasty website has an appealing design - where the recipes appear in a grid-like organized format, allowing users to navigate the website with ease [21]. The website is formulated

neatly where recipes are categorized into multiple categories - such as *"Neat Dinners"* and *"Work Lunches"*. The website contains multiple recipe collections where the latest recipes and popular recipes are both included. The search query has an auto-complete search where users find recipes and its suggestions based on the query. Users are able to search for recipes based on various filters such as dietary requirements, cuisine, and occasion. Regarding the each individual recipe template in the website, each recipe contains the percentage of users who would make the recipe and users are also allowed provide tips or comments about the recipe. Each recipe is accompanied with a video on how to make the recipe and its *"Suggested Recipes"* where recommended recipes based on the recipe are clearly shown.

Epicurious website has a clean user interface where components are not cluttered [22]. The main homepage clearly showcases both a *"Search"* functionality for users to quickly find recipes based on a search query and also a *"Advanced Search"* functionality where users are able to search for recipes based on the search query and numerous filters. The recipes appear in a grid-like organized format, where three recipes are shown in one row at a time. One notable filter include searching recipes based on *"Include/Exclude Ingredients"* where users can find recipes including or/and excluding ingredients. Recipes can be filtered by technique of making the dish such as *"Roast"* or *"Barbeque"*. The search results include plenty of content including a mixture of recipes, videos and articles. Each recipe contains the ingredients and steps required. The user can provide an overall rating and dish out comments regarding the recipe.

Unlike the previous websites mentioned earlier, **The Student Food Project** website is specifically targeted towards university students given its name [23]. Started by students from University of Portsmouth in 2015 and promoted by renown organizations such as BBC, they have promoted its hundreds of student-targeted recipes in their website. There is a *"Search"* functionality where users are able to find recipes based on a search query. Recipes are roughly formed into various categories in the navigation bar such as *"Sides & Snacks"* and *"Super Healthy"*. No advertisements are displayed throughout in the website. Dedicated articles specifically targeted for university students shown in the *"More To Read"* section. Each recipe page contains an image corresponding to the recipe title, number of servings, total cooking time, list of ingredients and the preparation steps.

2.7 Overview of Technologies Explored to Implement a Food Recipe Web Application for Students:

2.7.1 Web Crawling & Scraping and API

Understanding the technologies behind implementing the food recipe web application is crucial. While one may hear the terms ”Web Crawling” and ”Web Scraping” used interchangeably [24], web crawling or web spider is defined as the automatic navigation of web pages [24]. Web crawling is commonly used in many search engines such as Google to retrieve results [24]. On the other hand, web scraping is defined as extracting information from websites by parsing hypertext tags and obtaining embedded plain

text information from those tags [25]. This would involve creating a scraping template needed to obtain data from the web, taking the collection of unstructured data from a Web source and transforming the data into structured data. This can then be stored in a readable format such as a database [5]. However, the traditional approach for web scraping will require the scraping tool to be manually reconfigured when the web page structure changes [25]. Academic research continues to explore more efficient methods of web scraping [26].

An application programming interface (API) is used to access data through a set of predefined resources such as methods, objects and URLs [27]. This is particularly useful to obtain functionality in one's application instead of manually implementing it from scratch [27]. This encourages developers' productivity and efficiency in building web applications.

2.7.2 Recommended Food Recipes and Ranking

The study of food recipe recommendations methods have been explored by academia. Finding similar recipes based on a given recipe could be defined based on a user's food preferences and quantity of a given ingredient in that recipe [28]. Estimating the user's food preferences is based on the user's liked and disliked ingredients based on his/her cooking history [28]. We can calculate the frequency of ingredients used and specificity of ingredients to find the user's favorite ingredients and most disliked ingredients. The calculation is based on the term frequency-inverse document frequency (TF-IDF) [28].

2.8 Data Collection Methods

Data can be categorized into either quantitative or qualitative. Quantitative data takes the form of numbers where data is easier to be analyzed, whereas qualitative data only describes qualities and is generally harder to categorize [29]. This section describes three popular data collection methods - questionnaires, interviews and focus groups.

Depending on the types of questions asked and whether such answers can be quantified, questionnaires may contain both qualitative and quantitative data [30]. Questionnaires contain a series of questions which are used by the researcher to collect written information from respondents. Such questions can either be open-ended or closed-ended questions [31]. Closed-ended questions, such as categorical questions ('yes' or 'no') or questions containing intervals/ratios can be categorized as quantitative data, whereas open-ended questions are categorized as qualitative data [32]. This is particularly helpful where one would need many responses and obtain structured data which would be easier to analyze [31].

Interviews are ideal for collecting qualitative data. Interviews can be grouped into either one of the three categories: structured, semi-structured or unstructured [33]. Structured interviews are scripted and pre-defined questions are asked. There is no flexibility in the order of questions asked [33]. The interviewer is required to ask questions in the same format to each participant [34]. Semi-structured interviews are conducted where interviewees are asked questions from a pre-defined topic but these questions

may be followed up by others depending on the participants' replies [34]. Unstructured interviews are not planned ahead of time and questions are not scripted. The interviewer would ask an initial question and then ask follow-up questions based on the participants' responses [33].

Focus groups are also useful for collecting qualitative data. Focus groups are conducted with a small number of participants, ranging from five to ten participants [35], guided by a skilled moderator. In the form of a group conversation, the moderator would ask questions regarding a particular topic to the participants where the participants would discuss their opinions for each question with one another. This method of collecting qualitative data would hopefully encourage participants to provide genuine feedback [31]. Even though focus groups allow participants to express their opinions more freely, it may result in individuals with dominant personalities to take over the conversation. This requires the moderator to be skilled in guiding the focus group [35].

2.9 Data Analysis Methods and Tools

After collecting data, one would need to analyze the data. A feasible method is thematic analysis which is particularly used to analyze qualitative data. This is particularly useful for identifying themes or patterns within the obtained data. This process would initially start with familiarizing the data followed by coding, or labelling, of the qualitative data. [36]. From the given labels, one could identify possible themes.

NVivo is a tool used to analyze the qualitative data during the coding process [37]. Featuring the ability to transcribe sources such as text and video, NVivo helps to visualize centralizing data from multiple sources into one user interface makes this tool effective to identify themes and semantics [37]. These themes and semantics can be labelled as nodes in NVivo [37].

To analyse quantitative data, providing descriptive statistics allows researchers to summarize the data and provide patterns [38]. This is particularly helpful when research is limited to the sample data, and not to a consensus. A common statistic is the mean - the numerical average among values [38]. Another is the percentage - expressed how a group of respondents within the data relates to a large group of respondents [38]. Another statistic is the median - the data is sorted in ascending order and then the numeric value is taken in the middle of the set [39]. The median is not influenced by extreme or outlier values unlike the mean, which makes the median a more appealing descriptive statistic [39]. A more advanced statistic is the standard deviation to measure the variance of the data in relation to the mean [40].

2.10 Interaction Design and Design Heuristics

The conceptual idea of interaction design may be vaguely defined as simply creating desirable end-user interfaces which are ”easy-to-use” and ”intuitive” [41]. However, this definition alone fails to show how good design can truly be achieved. Design principles, which are clearly defined rules for end-user interface features, are needed to

establish the basis of excellent interaction design [41].

Gestalt Principles are general principles of human perception which articulate how objects should be perceived [42]. This may include how similar elements are grouped and pattern recognition. These principles particularly useful in regards to enhancing content organization on websites and interfaces. Don Norman established the idea of how interactions should be designed with his initial 6 principles of interaction design [43]. Other notable figures including Ben Shneiderman and Jakob Nielsen have expanded and refined Norman's initial six principles for interaction design. While there are many similarities between the authors' principles, but there exists some differences. Unlike Norman's principles, **Ben Shneiderman** additionally promoted the heuristics of reducing memory load for users and error prevention [44]. **Nielsen's 10 Heuristics** developed by Jakob Nielsen is well recognized for broad usability guidelines [45]. More information about each set of principles can be found in Appendix A.

2.11 Usability and its Evaluation Methods

Usability refers to the how easily users interact with a website or product [46]. Usability evaluations are effective in assessing and improving usability in systems [47]. Usability evaluation methods are classified into three categories: inspection, testing and inquiry [48]. In inspection methods, evaluators such as developers and users, examine the user interface's usability [47]. Testing methods are defined as participants having to complete a predetermined set of tasks on a system while the researcher records results of participants' work [48]. Finally, inquiry methods obtain informational feedback about the system from users [47].

Classified as an testing method, The **Think Aloud** method requires the user to verbalise each task and explaining their reasoning [49]. Even though this method is easy to conduct but the situation is unnatural for most users and users may tend to express their filtered opinions about the system as users would want to appear professional in their responses [49]. This may therefore result in having possibly inaccurate information about the system.

Assessing the usability for a system can also be conducted using a **System Usability Scale (SUS)**. Classified as a testing method, the 10-item likert-scale questionnaire contains five response options from Strongly Disagree to Strongly Agree [50]. The odd number questions in the SUS correspond to positive aspects of the system and even numbered questions correspond to negative aspects [51]. Even though it is quick for users to participate in the questionnaire, but the scoring system may be complex. Calculating the overall SUS score can be done by first tabulating the total score for all odd-numbered questions, then subtracting 5 from the total to obtain (A). Adding total score for all even-numbered questions, then subtract that total from 25 to obtain (B). The final total score can be calculated by adding those new values (A+B) and multiplying that value by 2.5 [52]. Determining the usability of a certain product may be relatively subjective based on certain scores alone. However attributing research contributed by Aaron Bangor, he has summarized the following in Table 2.1 [53]. The System Usability Scale has been praised by renown design critics. According to Aaron

Bangor's empirical study, the average SUS score is 70.14 based from 2324 surveys in 206 studies [54]. According to Andrew Smyk - a UX Designer Writer from Adobe, "Scores below 68 point to issues with the design that need to be researched and resolved, while scores higher than 68 indicate the need for minor improvements to the design" [52].

Acceptability Ranges	Mean SUS Score
Not Acceptable	Below 50
Marginal	50-70
Acceptable	Above 70

Table 2.1: SUS Acceptability Rating Table (Attributed by: Aaron Bangor) [53]

This paragraph classifies the following approaches as inspection methods. The **Stakeholder Walkthrough** involves all stakeholders, particularly the users, to evaluate prototypes of the system [55]. This is particularly useful to understand the perspectives of the end users more effectively to design and implement a more usable system, where participants are assigned to complete a pre-defined set of tasks and share their progress with them. Other usability evaluation methods worth mentioning include **Feature Inspection** and **Cognitive Walkthroughs**. Feature inspection lists out sequence of steps to achieve tasks required. This method addresses possibly cumbersome or unnatural steps[56]. While cognitive walkthrough is similar to feature inspection, but this approach involves the researcher evaluating the system rather than the users [57]. It additionally assesses if the user's goals and memory can correctly lead to the next correct action [56]. The researcher would ask the four questions when performing each action. The cognitive walkthrough questions can be found in Appendix A. While those evaluation methods mentioned are useful, but those methods consume a lot of time and may not be the most suited for a highly time-constrained project.

2.12 Software Development Process

Knowledge in some of the software development processes is essential for software developers to build software more effectively, ranging from the planning to implementation. The **waterfall model**, is one of the earlier models known for its sequential software development model [58]. This process ensures each phase of development is done in order without any overlap [59]. While this method shows out what steps are needed for each stage more clearly but it is problematic if requirements quickly change because it would fail to consider the new requirements [59]. Those new requirements would not be considered in the design or implementation.

Agile development fixes the problem mentioned earlier. The following methodology is an iterative approach to both software development and project management where requirements, design, and implementation are done in parallel in each iteration [59]. Focusing on the software development process, this approach considers feedback at regular intervals, such as every week, which facilitates change based from quickly-changing requirements [59]. This process identifies problems early and ultimately creates less challenges in scaling the product.

Chapter 3

Methodology

The following chapter describes in-detail how each step of the project is executed and the tools used to carry the project

3.1 Process Overview

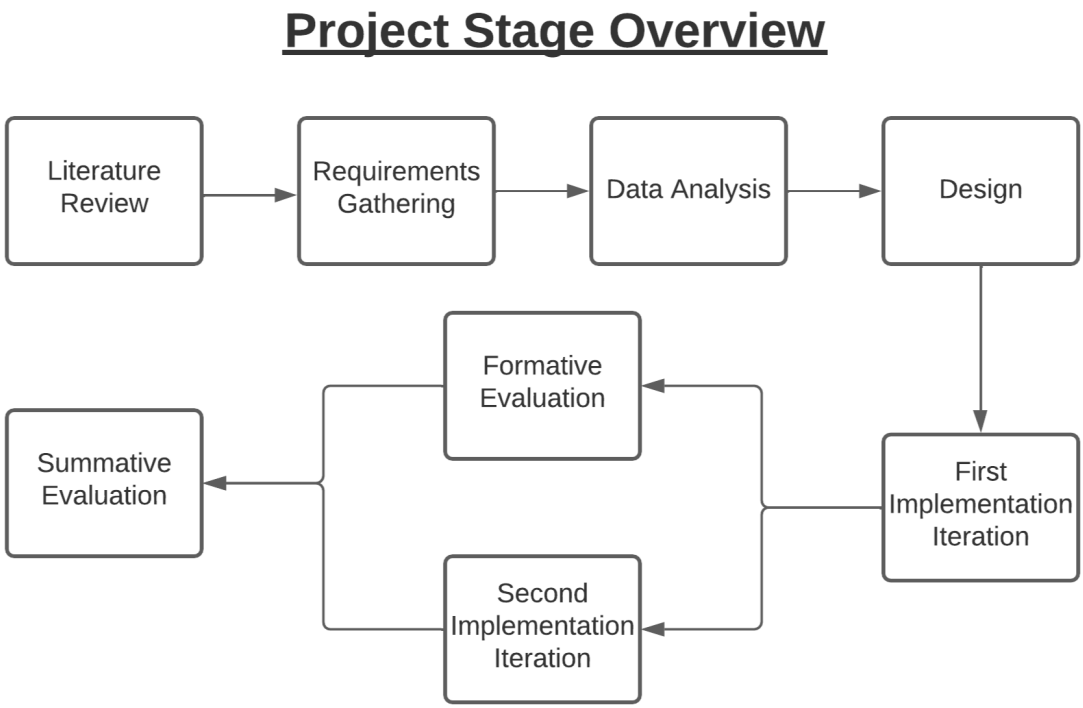

Figure 3.1: Project Stage Overview

I initially considered using the **Waterfall Model** [Background - 2.12] to manage the project sequentially. Even though the model clearly outlines the steps required to fully develop the project, this additionally results incorporating new changes more challenging. Such new changes are needed as university students continuously would

want functionalities in the food recipe website that suit their needs. Therefore I decided to adopt a more flexible approach - **agile development process** [Background - 2.12] in the project stage overview process. By creating two iterations of the implementation using an **agile development** approach, I would conduct the design and implementation in parallel, as well as gathering additional requirements at the same time. In addition, the targeted users would gain an insight of the developing product to obtain their feedback.

3.2 Requirements Gathering and Data Analysis

The Requirements Gathering process involved collecting and analysing data from potential end users - university students - in order to extract requirements. During the data collection process, I created a questionnaire which was intended to help me answer Research Questions (RQ) 1 and 2 [Introduction - 1.2]. Design workshops [Background - 2.8] were conducted to further understand what aspects do university students like and dislike about online food recipe sources and what features & improvements they appreciated in a food recipe website. These workshops directly answers RQ 3 and 4 [Introduction - 1.2]. The workshops also answers RQ #5 regarding how a food recipe website targeted for university students should be designed.

A questionnaire [Background - 2.8] based on the background material described earlier would be presented to University of Edinburgh students given consent, where the questions aimed to collect both qualitative and quantitative data. This approach was ideal to obtain a large number of responses in a short amount of time. The design workshops consisted of a combination of focus groups and prototype drawings, where students were asked to draw their ideal perceptions of the food recipe website's user interface. As the web application is targeted for students themselves, conducting the design workshops [Background - 2.8] of 5-7 students for each session was an ideal approach to understand more about university students and their needs regarding a food recipe web application [Appendix D.2]. While I have considered other data collection methods such as interviews and interviews [Background - 2.8], the limited time constraints for this project make the methods infeasible.

Based from the results from the questionnaire and initial focus groups, 2 methods of data analysis was conducted to assess both qualitative and quantitative data [Background - 2.8]. For qualitative data, I identified themes and patterns from the qualitative responses in the questionnaire and audio transcripts from the focus groups using NVivo [Background - 2.9]. Regarding quantitative data, I calculated descriptive statistics including mean, frequency, and outlier values where they were useful to identify topic areas of possible interest [38]. This approach would be useful for identifying what students particularly need for a food recipe website targeted for them.

3.3 Design

During this phase, I attempted to answer RQs 4 and 5: What features and improvements would university students appreciate in a food recipe website? What existing food

recipe websites do university students use? How should a food recipe website targeted for university students be designed?

Due to limited time constraints given for the project, I decided to first quickly hand-draw sketches of my proposed design. The design was inspired from the initial requirements list I had created and participants' designs from the design workshops (Refer to Figures 5.5-5.7). This was then followed by feedback by my supervisors. Using an **agile development approach** [Background - 2.12]. The design would continuously get feedback from students and supervisors to ensure the web application would satisfy the end users' requirements while I continued on the implementation of the food recipe website. The process would be followed by designing the server architecture to obtain a strong overview how the web application would function. This follows excellent design practices of software engineering. I then focused on assemble the static design [Design - Figure 5.2] and visualize it using a high-level Unified Modelling Language (UML) Class Diagram using objects, attributes, and relationships. I also created a dynamic design using a UML Activity Diagram to clearly illustrate the flowchart how the system works [Design - Figure 5.3].

3.4 Implementation

This section aims to specifically answer RQ#6 - How should a food recipe website targeted for university students be implemented?

I chose Python [60] because of my strong proficiency with the programming language and the language has an established support in web scraping libraries. I used Flask as a Python web application framework [61]. MongoDB [62] was used as the database to store the unstructured data collected from web scraping the food recipes. BootStrap was used to ensure the responsiveness of the web application would be supported for mobile and desktop interfaces [63]. Each list of requirements was generated for each implementation round due to the continuous feedback received from university students and my supervisors. Given the extensive list of requirements gathered from the questionnaires and design workshops [Figure - 4.1, they would be strongly supported on the back-end in Python. The website's front-end is designed to ensure usability evaluated by university students [Background - 2.10].

3.5 Evaluation

This section aims to answer RQ#7 - What are the students' perceptions about the developed system with regards to:

1. usability?
2. potential impact on their cooking habits, in general and compared to existing food recipe websites?

As shown in Figure 3.1, I conducted two iterations of evaluation shown in the project process overview. As the formative evaluation was conducted shortly after the first

round of implementation, I first created a questionnaire which asked students what food recipe websites they used and then asked users to complete a set of pre-defined tasks in the website prototype and how successful they were in completing those tasks. Users were also asked to rate the website's design and provide feedback about the first iteration of the researcher's implementation of a food recipe website targeted for students. Finally the System Usability Scale (SUS) questionnaire was provided for students to complete.

The summative evaluation was conducted in the combined format of a focus group and stakeholder walkthrough [Background - 2.8]. The stakeholder walkthrough was conducted where users completed a set of pre-defined tasks in the website prototype and shared their progress with one another. They were asked to describe what steps were taken to complete those tasks and shared what challenges or interesting facts they found. The focus group was conducted for participants to discuss about their perceptions of the website's implementation and how incentived would they use the website in comparison with other food recipe websites. This was required to gain a further understanding of the website's usability and how my website created a potential impact on their cooking habits. In addition, the study gives an insight in comparing students' perceived usage of my perceived website usage relative to other food recipe websites.

While I considered other evaluation methods for this project such as the cognitive walkthrough and feature inspection [Background - 2.11], but the evaluation methods mentioned consume a lot of time and may not be the most suited for a highly time-constrained project.

Chapter 4

Requirements Gathering

During the rigorous requirements gathering phrase, I conducted this process into three stages. I first conducted a questionnaire followed by two design workshop sessions with university students. The design workshops are in the format of focus groups [Background - 2.8]. The following studies were certified by the University of Edinburgh School of Informatics Research Ethics Process team, with the RT number 2019/11901.

4.1 Aims

During this phase, the main objective was to learn more about university students in Edinburgh and what online and offline resources students use to cook food recipes. This was covered in the questionnaire. The design workshops' aims were to help me understand what features and improvements would they appreciate in a food recipe website targeted for them. This phase aims to cover the Research Questions 1-4, and partially RQ 5 regarding how the food recipe website targeted for university students should be designed.

4.2 Participants

87 students from the University of Edinburgh responded to the questionnaire. University of Edinburgh students are chosen for the questionnaire, because students are the target audience for the following project study and the easiest for us to have access to. 10 students additionally agreed to participate in the two design workshops, where each workshop had 5 participants and the researcher acted as a moderator to facilitate the workshops.

4.3 Data Collection Methods

I initially started with a questionnaire provided online on Microsoft Forms to collect information about the student participants in response to Research Questions (RQs) #1-2. This method would obtain a large number of responses from the university

students themselves. Even though I obtained had some prior knowledge needed through literature review, but the questionnaire collects the information for the potential end-users themselves. The design workshops were directed to answer RQs#3-5. Regarding the 1-hour design workshop sessions, they were conducted online on the university's platform of Zoom. The workshops integrated focus groups – where groups of 5-6 participants in each session are formed to discuss relevant questions about a certain topic. Participants would then use Padlet to add virtual sticky notes to enter features they would like to see in a food recipe website targeted for students. Participants would then vote for the top 2 features. Participants would then individually draw out prototypes of web pages on paper which included those features. Participants would then send their drawings on paper to the researcher's email. The workshop would end with a focus group session where participants would discuss elements and features which should be included in the food recipe website targeted for university students. The design workshop questions can be referred in [Appendix D.2]. Being semi-structured, this would hopefully generate a wider range of feedback for those topics [64].

4.4 Materials

The Participant Information Sheet (PIS) forms were given to potential participants which highlighted the goals and purposes, as well as how their data is stored, used and shared. These forms were used for the questionnaire and design workshops. The consent form was also composed to obtain consent from the participants, which ensured that their participation was voluntary and agreed to have their data recorded for ethically-approved research. The consent form for the design workshop was slightly modified to ensure they agreed to have them both audio and video recorded. Please refer to the Appendix for the consent and PIS forms.

4.5 Procedure

Firstly, the questionnaire was sent to all university students through several means - this included different undergraduate and postgraduate year mailing lists, social media groups, and targeting students known by the researcher and supervisor. The questionnaire contained the PIS form linked at its start.

Regarding the design workshops, the PIS and consent forms were sent to students who volunteer to participate as part of the questionnaire, which allowed them to agree with the information before fully compiling with the study. A Doodle poll was then sent to interested participants, requesting which time-slot would suit them the most. The time-slot containing majority of votes would be selected.

Moderating the design workshops groups was challenging but required to ensure data bias from one person did not occur. I used a round-robin technique to ensure everyone in the group had an opportunity to explain their opinions about a topic or describing their perceived website prototypes.

4.6 Data Analysis Overview

The meticulous data analysis for quantitative and qualitative data was conducted after collecting the data from questionnaire and design workshops. Regarding the design workshops, I utilized the automatic subtitling feature from Zoom to obtain the transcripts. Those transcripts were then used to listen to the audios.

Focusing on quantitative data, the questionnaire was analyzed using descriptive statistics [Background - 2.9]. The results were summarized from the data using mean and frequency. These statistics would help support the justification for each requirement found in the List of Requirements [Requirements Gathering - 4.8].

The qualitative questions in the questionnaire and workshops were analyzed through NVivo [Background - 2.10] using thematic analysis and a combination of top-down and bottom-up coding [65]. The design workshops were analyzed using a top-down coding approach, as the questions were driven by specific research questions in the following study [Introduction - 1.2] [65]. On the other hand, the questionnaire was analyzed with a combination of top-down and bottom-up approach. Themes and sub-themes were clearly identified for each qualitative question. The audio transcripts were manually verified again after analyzing the interviews to ensure the correlation between statements and themes were correctly identified. The full list of nodes can be seen in [Appendix E]. The drawings from the design workshops were analyzed to help create the initial list of requirements shown in Section 4.8.

4.7 Results

4.7.1 Quantitative and Qualitative Data Analysis Results from the Questionnaire

- **Demographics of University Students**
  - **Food Spending Budget**: More than half of the respondents (48/87 or approximately 56%) have indicated that they approximately spend 30-60 pounds per week. About a quarter of the total responses (23/87 or approximately 27%) have indicated they spend between 0-30 pounds per week.
  - **Cooking Frequency**: More than half of respondents (44/85 or 52%) indicating they cook every day. Even though the biggest group (30/85 or 35%) said that most participants are willing to cook between 45-60 minutes per day but the median is actually 30-45 minutes per day. Perhaps the study enticed more individuals who cook to answer the questionnaire, which results in the questionnaire indicating that they are willing to spend more time cooking compared to others.
- **Factors which affect students' eating and cooking perceptions**
  - **Healthy Eating**: For those who do cook, 96.5% of respondents agree that the food choices in what one eats matter and 95.1% of them agree that obtaining a balanced diet is a priority.

  - **Barriers to Cooking**: Time clearly is a recurring theme for majority of students, where 76 of 87 respondents picked the option that the factor of academic commitments may prevent them from cooking. Out of 87 respondents, 46 declared that short life of ingredients or/and food and 48 said planning what to eat are contributing factors to preventing one from cooking. *"Cooking requires too much time, ingredients and steps" - s26*

- **What online and offline resources do students use to cook food recipes?**: Regarding offline sources, most participants picked "Family and/or Friends" (59/87 respondents). However, popular online sources including Youtube and BBCGoodFood also top the list, 47 and 46 respondents respectively. 10 out of 87 use Tasty to find recipes one has in the kitchen. Using a search engine, particularly Google, was a notable response where 11 out of 87 respondents indicated they use a search engine.

  "I never aimed for a specific website, just used a search engine and usually the first or second hit" - s65

  Only 6 out of the 87 respondents use meal-kits to feed themselves. Perhaps this could be due to the limited market of meal-kit delivery [Background - 2.5].

- **What Students Like and Dislike about Online Food Recipe Sources**

  Only 30 students responded to the question. Out of those 30 responses, about half (14/30) indicated they liked online food recipe sources because the websites were "easy to follow and understand".

  "I like them because they can teach me how to properly process certain food and I learn a lot of strategies from just following the recipe." - s15

  Only 22 students responded to the question. Slightly less half of the responses (10/22) indicated they disliked the online food recipe sources because they consisted of inaccurate measurements. *"If Im looking at a recipe for 4 people and just want to cook for myself, it's a hassle to work out ingredient amounts and potentially wasteful." - s31*

  In addition, 8/22 (36%) of the responses clearly indicated that the usage of ingredients were not feasible. This indicated too many ingredients or lack of substitute ingredients for recipes which frustrated them.

  "Some ingredients can be hard to find...recipes require too many ingredients/spices that I don't just have in my cupboard" - s6 and s32

4.7.2 Design Workshop Data Analysis Results

- **What features and improvements would university students appreciate in a food recipe website targeted for them? How a Food Recipe Website targeted for University Students should be Designed**

  - **Search Engine**: 6 of the 10 participants clearly indicate their interest in an improved search engine for such a website, particularly search recipes

based on filters. This includes cooking time, dietary requirements, cuisine and certain ingredients.

"...a filter for different tags like different things, for example, if you wanted to search by category like by cuisine or by dietary requirement or by preparation time." - s5

"...my friends are like vegan or gluten free or something, it'd be nice to filter for recipes" - s6

– **Search Results should be clearly displayed**: Interestingly the following feature is supported by 5 out of the 10 respondents. It matches well with Nielsen's Heuristics #8 - Aesthetic and Minimalist Design [Appendix A], where interfaces should not contain unnecessary material.

"convey all that information in a spaced out manner without overwhelming them" - s9"

– **Equipment / Utensils Required for Recipe**: The following feature is supported by 5 out of 10 respondents.

"sometimes I've been like going through this recipe, and following the steps and then realize I don't have quite the correct essential utensils" - s4

– **No advertisements**: This feature was supported by 5 out of 10 respondents.

"I know you can just use AdBlocker but the ads can clutter up the page...so I only would consider [food recipe websites] like Epicurious if they didn't really have ads" - s9

– **Recipe Ingredients Price Cost Breakdown**: This feature was proposed by 4 out of 10 respondents. This would be a particularly defining feature for the website as existing well-known food recipe websites currently have not implemented this feature [Requirements Gathering - 4.9].

"It would be useful to have the recipe cost along with corresponding recipe ingredients with the ingredients" - s4

4.8 List of Requirements

The list of requirements obtained from the initial questionnaire and design workshops can be shown in the following figure 4.1. Given individuals' needs rapidly change, therefore I needed to adopt an 'agile development' approach [Background - 2.14] to adapt to the quick change of the list of requirements. Therefore requirements continue to be appended with new functionalities to be expected. Each requirement is assigned to a priority level, which distinguishes what requirements should be implemented in my design. The list below explains the priority justification further:

- High: Majority of total participants is greater than 2/3
- Medium-High: Approximately half of participants from workshop and/or questionnaire

- Medium: Less than 50% of participants but high impact
- Medium-Low: Less than 50% of participants but very interesting
- Low: At least one participant indicated this functionality should be added or a high level of technical competency is required

#	Requirement	Priority	Justification
R1	No Ads	Medium-High	Supported by 5/10 respondents from design workshops.
R2	Initial food recipe collection - BBCGoodFood	High	Supported by 46/87 respondents from the questionnaire. Additionally supported by 8/10 participant from design workshops.
R3	Next food recipe collection is from Tasty	Medium-Low	Supported by 10/87 respondents from the questionnaire. Assigned with lower priority due to little project implementation duration
R4	Showcases 'Featured Recipes' section	Medium	Supported by 3/10 respondents from design workshops based from their visuals. Less than 1/2 of total participants but creates high impact for usability
R5	Relevant recipes can be sorted	Low	Supported by 1/10 respondents from design workshops.
R6	Search engine	Medium-High	Supported by 6/10 respondents from design workshops. This feature is labeled in particular with a high impact that users would certainly want to query recipes based on a recipe name, ingredient or keyword.
R7	Search By - Maximum Cooking Time	Medium-High	Supported by 3/10 respondents from design workshops based from their visuals.
R8	Search By Dietary Requirement	Medium-High	Supported by 2/10 respondents from design workshops based from their visuals.
R9	Search By - Include / Exclude Ingredients	Medium-High	Supported by 3/10 respondents from design workshops based from their visuals.
R10	Search results should be clearly displayed	Medium-High	Supported by 5/10 respondents from design workshops. In addition, high impact is justified with following the 1st heuristic of Nielsen's 10 Usability Heuristics - Visibility of System Status
R11	Title, Author, Website Used	Medium-High	While this was not addressed in the design workshops, this prevents copyright infringement.
R12	An image should be displayed for each step of making recipe	Low	Even though it was supported by 4/10 respondents from design workshops but the high level of technicality required to determine what image should be shown with equipment and ingredients is challenging
R13	Cooking Time Duration	High	76 of 87 respondents in the questionnaire agree that they have too little time to cook due to academic commitments. Additionally supported by 7/10 participants from design workshops.
R14	Equipment / Utensils Required for Recipe	Medium-High	Supported by 5/10 respondents from design workshops. While web scraping the recipe data does not indicate equipment used in the recipe, integration of a Food Recipe API will be required.
R15	Nutrition Information	Medium	Supported by 2/10 respondents from design workshops. In addition, 45% of questionnaire participants strongly agreed obtaining a balanced diet is a priority.
R16	Recipe Ingredients Price Breakdown	Medium	Supported by 4/10 respondents from design workshops.
R17	Cuisine type should be displayed	Medium	Supported by 3/10 respondents from design workshops based on visuals.
R18	Recommendation Feature -display recipes with similar ingredients	Medium	Supported by 3/10 respondents from design workshops. However, implementing an advanced algorithm that suggests similar recipes will certainly be a challenge.
R19	Ability to change number of servings	Medium-Low	The integration of Spoonacular API will determine the semantic text in order to change number of servings based on ingredients shown
R20	Recipe Page should have functionality to convert measurements for ingredients	Medium-Low	The integration of Spoonacular API will determine the semantic text in order to convert measurements
R21	User Login System where user can save his/her favorite recipes	Low	The high level of technicality required to handle routing, saving user session data into another database. In addition, consideration of confidentiality of user data must be ensured.

Figure 4.1: Initial Set of Requirements from Questionnaire and Design Workshop

	Requirements Met	Requirements Partially Met	Requirements Not Met
BBCGoodFood	R4-R8,R10,R11,R13,R15,R18,R21	R9	R1,R12,R14,R16,R17,R19,R20
Tasty	R4-R7,R8,R10,R18	R11,R13,R15	R1,R9,R12,R14,R16,R17,R19,R20,R21
Epicurious	R4-R6,R8,R9,R10,R11,R13,R18		R1,R7,R12,R14-17,R19-21
StudentFoodProject	R1,R4,R11,R13	R6,R10,R18	R7-R9,R12,R14-17,R19-21

Table 4.1: Comparison of Existing Food Recipe Websites

4.9 Comparison of Existing Food Recipe Websites

The comparison of existing food recipe websites can be justified based from the list of requirements generated from Section 4.8.

Even though BBCGoodFood website contains most of the requirements listed above, the recipe website could be improved further by implementing additional functionalities. While BBCGoodFood has an effective search engine (R6) which allows the functionality to include **multiple** ingredients when searching for recipes, but one cannot exclude ingredients (R9). Therefore R9 is only partially met. BBCGoodFood also allows the users to save recipes (R21).

While Tasty also has a powerful search engine (R6) like BBCGoodFood and has some requirements fully met, there remains areas of improvement. Some of the recipes listed do not meet R11, where the title, author and website used is not displayed. In addition, some recipes also do not display the cooking time (R13) and the nutritional information (R15). Therefore those functionalities are only partially met. The search filtering functionality is not optimal, as one could filter recipes based on dietary requirements (R8) but not the maximum cooking time (R7).

Epicurious contains most of the requirements similiarly to BBCGoodFood and Tasty. However unlike BBCGoodFood or Tasty, Epicurious has the unique functionality to filter recipes on both including and excluding ingredients (R9). It additionally lacks the ability to filter recipes based on maximum cooking time (R7).

Lastly, the StudentFoodProject contains the least number of requirements met compared to the previously mentioned websites. Unlike the previous mentioned websites, there are no advertisements shown (R1). While the website is specifically targeted for university students, there remains many areas of potential improvement. While the website does have a simple search query to find recipes (R6), but there is no ability to search for recipes (R6) based on filters like dietary requirements or cooking time (R7-R8). R10 is only partially met because the search results do not clearly show the results visually and do not contain images corresponding to the recipe titles.

As shown above, certain functionality does not exist entirely in all of the previous websites. Displaying the image for each recipe cooking/preparation step is not shown (R12). Features such as calculating the estimated costs for each recipe and its corresponding ingredients in each recipe (R16). In addition, the recipes are not labelled with its cuisine (R17). Conversion between Imperial and Metric measurements currently do not exist yet (R19-20). With BBCGoodFood website having the most number of requirements met based from the table, it may be concluded why BBCGoodFood website remains a relatively popular food recipe website targeted for university students than others. However, there yet exists a large potential of improvement in food recipe websites.

Chapter 5

Design

5.1 Server Architecture

Following the requirements gathering process, the challenge of designing the food recipe web application still remains. I have therefore proposed the following web application architecture design in the diagram in figure 5.1:

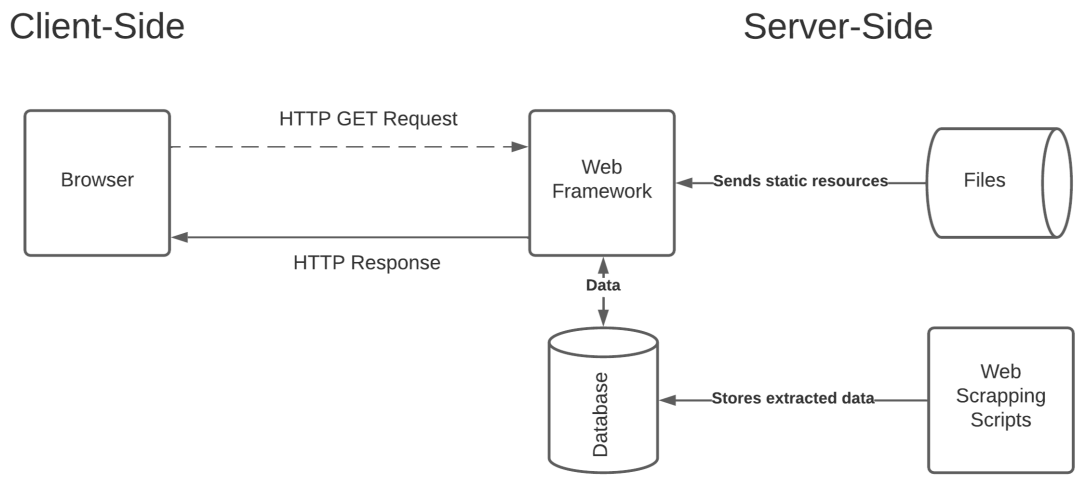

Figure 5.1: Server Architecture Design

The design is based of the Client-Server architecture [66]. Firstly the data extraction from the recipe websites was conducted using web scrapping techniques. This automatic approach is useful for collecting large amounts of data from the Internet [25]. Once the data was extracted, it was stored on a database. This architecture is required as showing the recipe content on the website varies, depending on what recipes the users search for. An in-depth explanation can be found in the Implementation Chapter # 6.

5.2 Static and Dynamic Design of the Functionality

As the system design continues to increase in complexity due to future requirements, the system should remain easy to maintain and satisfies current requirements [Background - 2.12] [67]. As shown in Figure 5.2, the UML class diagram was utilized to showcase classes, objects, attributes and relationships among objects [67]. The activity diagram to clearly illustrate how the logical process of how the website functions as shown in Figure 5.3. The UML Class Diagram and Activity Diagram were illustrated using LucidChart [68], as LucidChart is a popular tool used by many Fortune 500 companies [68].

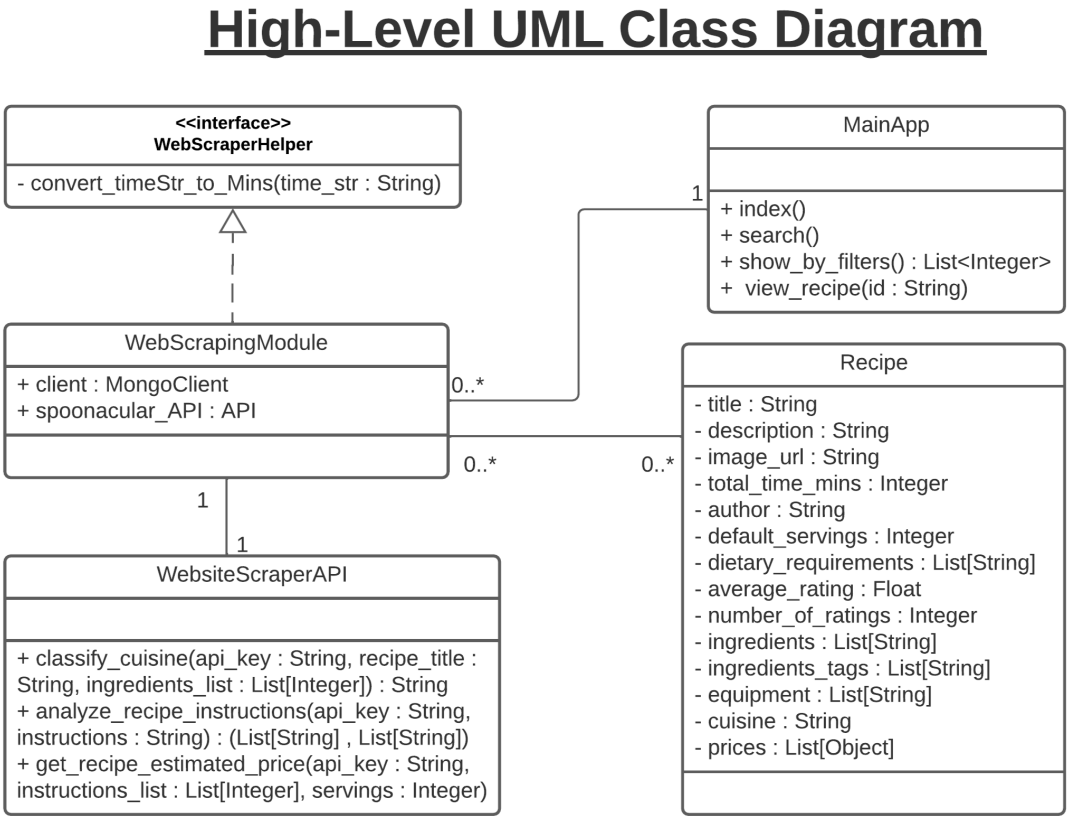

Figure 5.2: UML Class Diagram

Explaining the UML Class Diagram further with respect to my web application shown in Figure 5.2, the *Recipe* class contains the attributes for each recipe, which a collection of Recipes are stored in the database. These attributes are required for fulfilling the list of requirements shown in Section 4.8. The WebScraping components are divided into three classes for modularization purposes in good software engineering practices [67]. The **WebsiteScraperAPI** class corresponds to an API which contains three methods: classify the estimated cuisine for each recipe, separate the recipe text to obtain the recipe instructions and ingredients (this is used to meet R9 to allow include/exclude ingredients when searching for ingredients), and finally get the recipe's estimated price. The **WebScrapingModule** class instantiates a client attribute which connects the database with the web scraping scripts, and an API class. The class also

implements the *WebScraperHelper* class which converts the *'time'* string attribute into an integer to search and filter recipes based on the maximum cooking time functionality. Finally, the **MainApp** class contains functions: index() to render the main homepage website, search() for the functionality to search and filter recipes, and view() to view the individual recipe webpage.

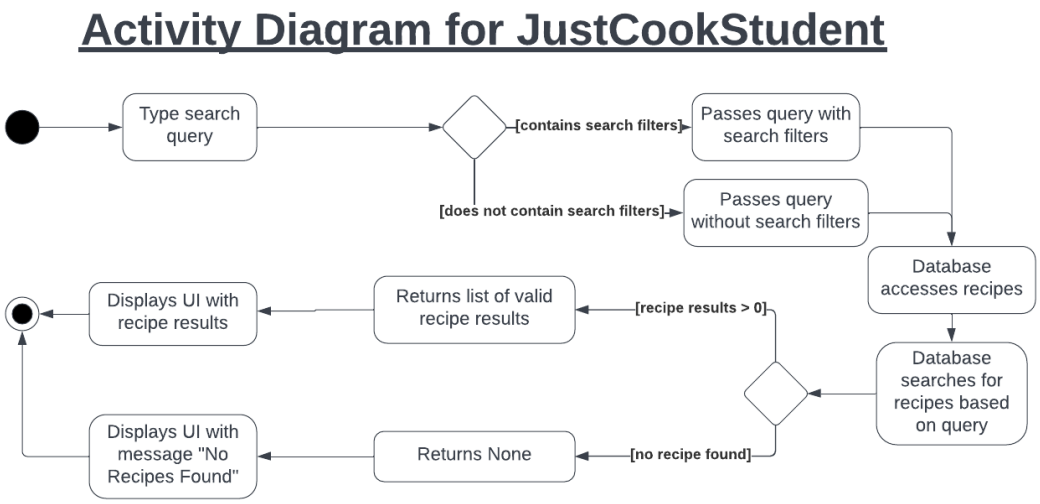

Figure 5.3: UML Activity Diagram

The activity diagram shows the high-level overview of the perceived implementation of how searching for the food recipes in my website would work. In this scenario, the black circle or starting node is represented as the user accessing the website homepage. [69]. The user would type a search query into the search-bar for finding recipes. The decision nodes were implemented to check if user added search filters or not [69]. The collection of food recipes are accessed from its database and then it searches for recipes based on the user's passed inputs. Decision nodes are also used to check if recipes were found or not. Depending on the outcome, it would either display the user interface with the relevant recipe results or none. The outlined black circle or ending node in the diagram represents the user being shown the webpage showcasing the list of relevant recipes from the search [69].

5.3 User Interface Design Decisions

This design aims to achieve all of the requirements shown in Figure 4.1. With justifying the design decisions made for the User Interface (UI) for the website ensures usability. I used Google Fonts **Poppins** for the website's typography [70]. The minimalist design was chosen for its boldness and font appealing for university students in particular. In addition, I utilized the BootStrap CSS library to ensure responsiveness for both mobile and desktop design for the website [63]. Utilizing mobile design would be important for this project, as approximately 2 billion people currently access the Internet via smartphones and the estimated number equates to approximately 3.7 billion individuals

in 2025 [71].

5.4 User Interface Design

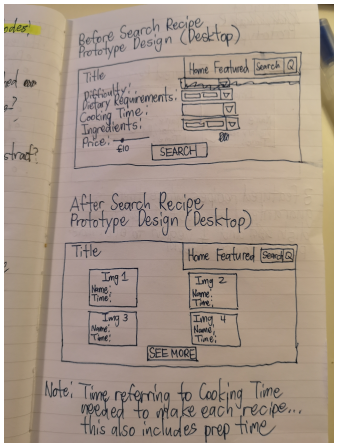

Figure 5.4: Overall Recipe Prototype Sketch Design

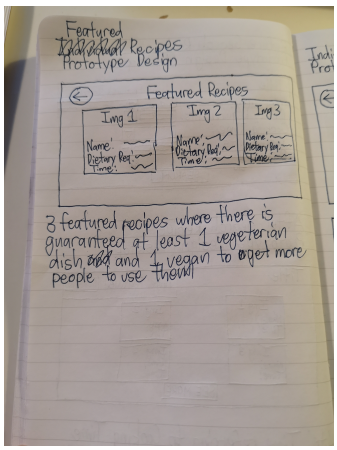

Figure 5.5: Featured Recipe Page Sketch Design

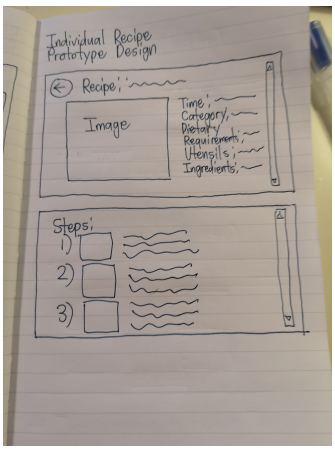

Figure 5.6: Individual Recipe Page Sketch Design

The UI design aims to achieve all the initial requirements. The typical design process for such a web application is long. This would first involve creating a sketch, developing a wireframe, mockup and finally a design prototype. Given the limited time constraints, I drew out sketch prototypes for my design as shown in Figures 5.4 to 5.6 based from the justification found in the Requirements Gathering phase. The top figure drawn in Figure 5.4 illustrates my perceived food recipe website design to show the Homepage containing the search engine and its search filters. The bottom figure in Figure 5.4 shows the food recipe results from the user's search query. This ultimately aims to achieve R6-10 in the implementation. Shown in Figure 5.5, the sketch design shows the Feature Recipe page (R4). In figure 5.6, the individual recipe page sketch shows multiple attributes of what the recipe should have. This includes the cooking time, list of equipment/utensils, cuisine, cooking steps, ingredients, and an image displayed for each step of making the recipe (R13,R14,R17,R12). The design workshop sessions largely influenced my prototype design, as I would ideally want to input students' feedback into the website. The design workshop sessions drawings can be referred in [Appendix D.3]. I was not able to translate every single requirement into the sketches - I conducted the design and iteration in parallel using the agile development approach [Background - 2.12], which would continuously revamp the initial design proposed in this section. If additional time was given to the project, using Balsmiq [72] as a design mockup and prototype would have been ideal.

Chapter 6

Implementation

This chapter explains in-detail the justification of technologies used to develop the food recipe website, server architecture and selection of API libraries. In addition, the details of the 2 phases of implementation are further elaborated.

6.1 Selection of Technologies

6.1.1 Web Scraping

With a large variety of web scraping libraries available to choose from [73], I ensured my implementation code reflected with the web scraping class modules shown in the UML Class Diagram located in Figure 5.2. Python [60] is arguably one of the most popular programming languages in data science, this would be particularly useful for web scraping to obtain food recipes. According to a study survey of about 2000 participants, about 65.2% use Python [74]. Given my strongest programming language is Python as of writing this report, it would be ideal to utilize Python for web scraping food recipe websites to store such information of recipes.

The Python HTML parsing library **BeautifulSoup** is effective in web scraping with excellent comprehensive documentation [75]. The library would be ideal to extract the unstructured data from a specific website, in the format of HTML, such as BBC-GoodFood. Another library is PyQuery, but it only supports the parsing of documents in XML format [76]. As website documents are in the format of HTML, PyQuery would therefore not be a feasible solution. Selenium [77] is a Python library and tool used for web-browser automation and testing. I additionally consider a web-crawling framework such as Scrapy to automatically collect more data from other recipe websites [75]. However using it would involve additionally search, collect and index other web pages. This process would be technically demanding and time-consuming. Therefore, we decided to focus on the web scraping component and propose web crawling as future work shown in Section 8.2.

6.1.2 Architectural Design

Flask [61] as the micro web-framework in my server architecture is an excellent choice to build the foundation of the food recipe web application due to its simple syntax and semantics, and high popularity among developers worldwide [78]. Features including routing, debugging, and good usage of templates, enable the above tool to handle dynamic content in web applications [78]. However, this micro web-framework does not directly integrate a database or deployment on the cloud and requires additional libraries such as PyMongo to connect Python code with MongoDB [79]. In addition, there exists a discrepancy in performance between Flask and Node.JS. A research case study conducted by Pia Løtvedt has compared the loading time it would take to load a chloropleth map of the world using those two different implementations of the server-client architecture [80]. Her results showed it would take approximately 4.9 ± 0.3 seconds to load the webpage using Flask where as it would take approximately 1.5 ± 0.6 seconds to do so [80]. Since this project is time-constrained and my stronger proficiency in Python rather than Node.JS encouraged me to implement the functionality of the web application, rather than performance would be ideal. Therefore, Flask would still be an excellent choice for the project. Possibly implementing the architecture using MEAN stack would considered as part of Future Work shown in Section 8.2.

Storing the collected information from web scrapping would require the usage of a database. Data is categorised into the following - unstructured and structured data [81]. There are a variety of databases supporting each one's needs. MySQL and MongoDB are well-recognized database technologies. MySQL, is a SQL-based database which stores structured data into tables with rows and columns [78]. MongoDB stores data into a JSON-like structure, its dynamic structure is well supported for web scrapping [78]. Since the web-scraped data collected is unstructured, it would be more feasible to use MongoDB rather than MySQL. As Flask does not support direct database integration [78], PyMongo would be a suitable module driver to connect the web server architecture with the MongoDB database [79].

TrustedPilot highly recommends RapidAPI for comparison of APIs.
Comparison of APIs is found in RapidAPI, where I was able to narrow my options into 2 strongest options

	Advantages	Disadvantages
Spoonacular	**Strong usage of semantic analysis applications** 1. Analyze recipe instructions 2. Convert ingredient amounts from imperial to metric (and vice-versa) **Other Applications:** 3. Add a recipe to a shopping list 4. Calculate estimated price (USD)? 5. Classify cuisine based on title and ingredients 6. Obtain most relevant Youtube food videos related to recipe 7. Usage: According to their website, hundreds of universities use it	1. Limited usage of points within 150 points so usage must be calculated carefully during honours project (but can be reasoned within limit)
Edaman	1. Has multiple categories of APIs: nutrition analysis, food database, recipe search API 2. Usage: According to their website, many companies worldwide use it (such as Microsoft and New York Times) 3. Nutriention API supports multiple diet classification including Keto-Diet 4. Large amount of Edamam food api database with 900,000 foods 5. Recipes prioritized based on cookability and quality	1. Very limited usage of points - only allowed to analyze 400 recipes per month for free plan. 10 2. Calculation of nutrition data is done individually 3. Limited endpoint calls - this lacks features such as obtaining equipment

Figure 6.1: Comparison of Food Recipe APIs

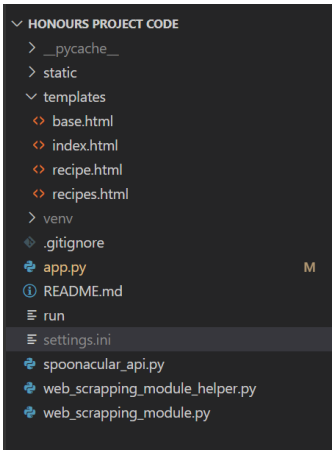

Figure 6.2: Code Structure - 1st Iteration

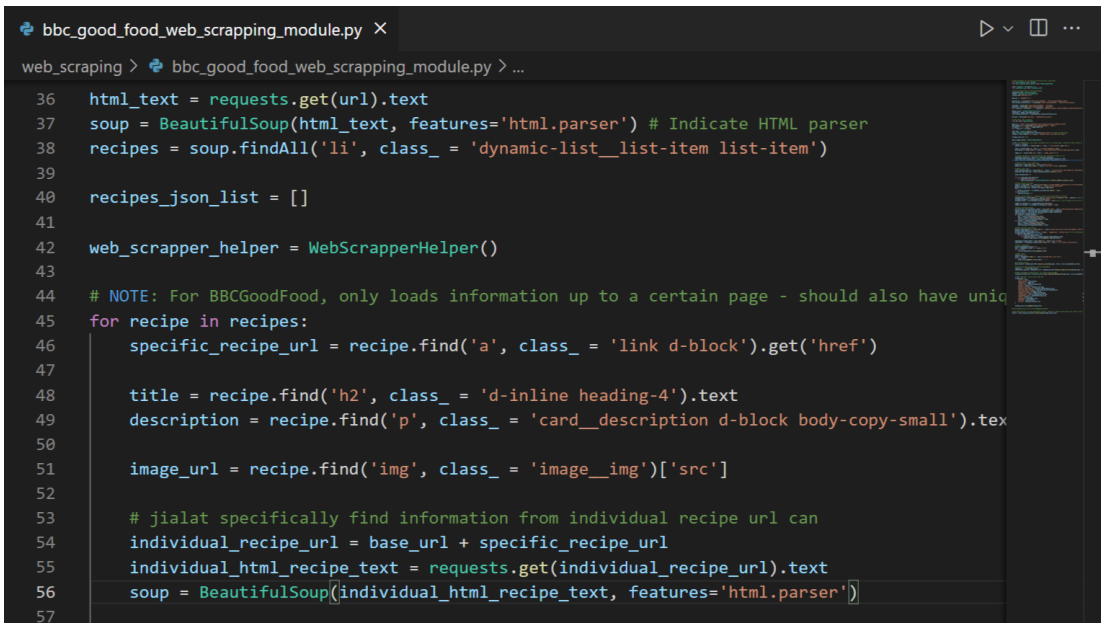

Figure 6.3: Web Scraping Code for BBCGoodFood Website

6.1.3 Application Programming Interface (APIs)

Unfortunately literature background information regarding the comparison of food recipe website APIs [Background - 2.7] currently does not exist. Given RapidAPI has a high rating on TrustPilot, I therefore decided to utilize RapidAPI in order to compare and contrast the functionalities of food recipe website APIs [82]. The table is then narrowed down to two finalized options - Spoonacular [83] and Edaman [84]. Integrating Spoonacular API into my food recipe website would be a more feasible option. This API would help meet the following RQs #9,16,17: search by ingredients, obtain the cost of the recipe and its corresponding ingredients, and finally classify recipe's cuisine. This contains more advantages than Edaman as shown in Figure 6.1. Therefore integrating an API for those functionalities means that implementing them from scratch is not needed.

6.2 First Iteration and its Formative Evaluation

6.2.1 How First Iteration Works

As shown in Figure 6.2, the code structure with Flask [61] as the web framework contains 'static' and 'templates' folders. The 'static' folder includes static files including images, CSS and JavaScript files. The template folder contains HTML templates for the homepage, recipes results and the individual recipe page. The Python file 'app.py' executes the web application with respect to the Server Architecture shown in [Design - 5.1]. The Python web scraping modules conduct the web scraping process for obtaining recipe information.

As there were no public APIs available to obtain food recipes from BBCGoodFood or Tasty websites, writing the Python script code for the web scraping template was

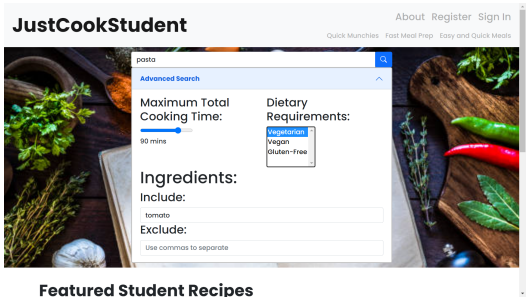

Figure 6.4: Homepage - Desktop

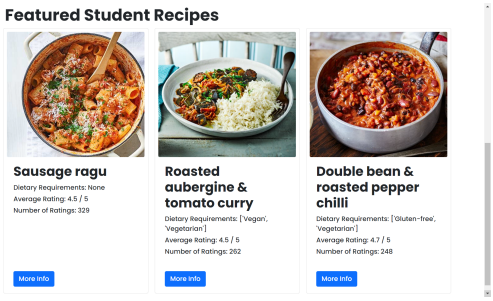

Figure 6.5: Featured Recipes Page

rather time-consuming. I followed the approach by Shilpa Chaudhari who developed an ingredient/algorithm using web scraping for a food recipe website [25]. Shown in my code structure, the web scraping module contains a main file and helper file. Utilizing good software engineering design principle of modularization as shown in Figure 5.2, the WebScraperHelper class only contains helper methods for the WebScraper class. The helper class has a function which converts the *time* type from String into an Integer [Design - 5.2] to meet the requirement to search and filter recipes based on maximum cooking time (R7).

6.2.2 How First Iteration Looks

Having an iterative approach using agile software development [Background - 2.14], I prioritized writing the time-consuming script for the web scraping modules in Python first. Implementing the back-end functionalities before the front-end will ensure the functionalities are well supported to be displayed. This approach prevents making errors.

The back-end of the application aims to implement the functionalities in the requirement list. The feature to have absolutely no advertisements (R1). Focusing on the backend, I first web scrapped the food recipe from BBCGoodFood website, particularly the Student Recipes collection (R2) shown in [Figure 6.3]. I then connected the Flask web server with MongoDB using PyMongo. The homepage search engine with advanced search filters including dietary requirements, maximum cooking time, and ingredients (R6-R9) shown in [Figure 6.6]. *Featured Recipes* are displayed in the homepage (R4) shown in [Figure 6.5]. Each recipe information showed the corresponding title, author and website used was displayed for each recipe (R11, R13) shown in [Figure 6.8]. Nutrition information for each recipe was also displayed (R15) shown in [Figure 6.8]. I then integrated Spoonacular API [83] to label the estimated cuisine and equipment/utensils for each recipe (R14, R17), as each recipe in BBCGoodFood did not show the list of equipment/utensils or cuisine for each recipe shown in [Figure 6.7]. As the web application requires additional features, the scaling and complexity of the code continuously increases. While I prioritized in finishing features with a minimum priority level of Medium, the difficulty in modifying design and maintaining good stance for continuous feedback made it a challenge.

Regarding the design decisions, MongoDB was used to store the recipe collections for BBCGoodFood and Tasty website shown in Figure 6.9 and the recipe attributes

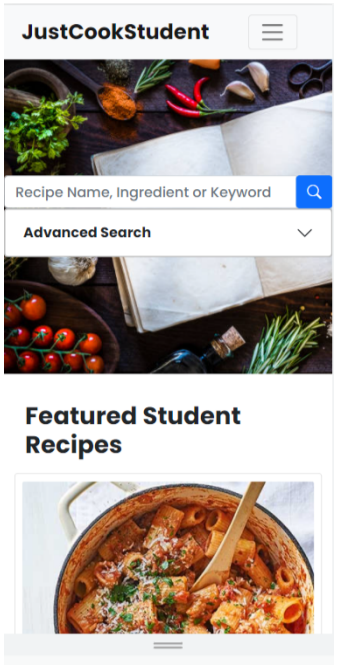

Figure 6.6: Homepage - Mobile

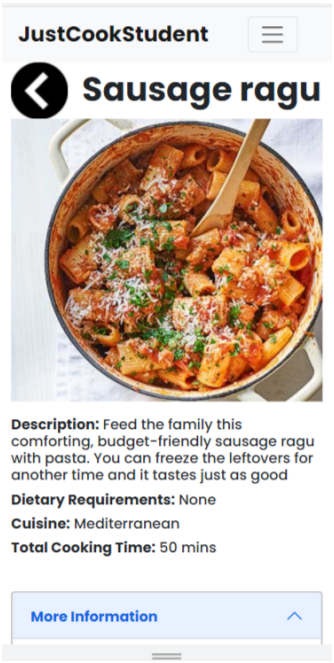

Figure 6.7: Sausage Ragu Page - Mobile

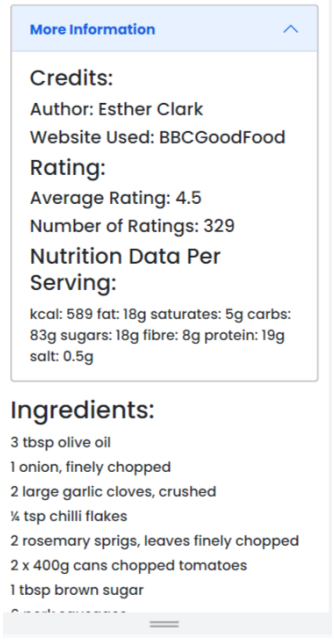

Figure 6.8: Sausage Ragu Page Part #2 - Mobile

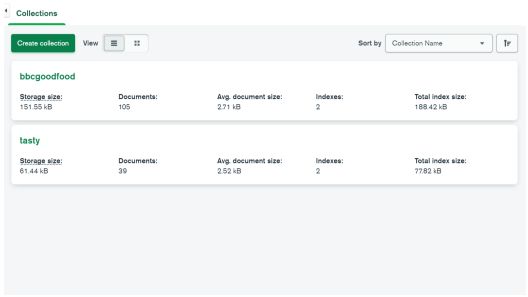

Figure 6.9: Database Design Overview

Figure 6.10: Database Design Document

were stored as documents in MongoDB shown in Figure 6.10. Before I conducted the formative evaluation, I was additionally required to deploy the web application on the university servers first. **Refer to [Appendix H] for the Server Deployment details.**

6.2.3 Formative Evaluation

6.2.3.1 Study Protocols

The following section aims to answer Research Question #7A: What are the students' perception about the developed system with regards to usability?

23 University of Edinburgh students took part in a formative evaluation questionnaire [Appendix F.3]. The first implementation prototype was only accessible on the Informatics servers and eventually in university servers, therefore the web application was only accessible within the university network due to web security reasons. This resulted in having less participants than expected due to the constraints.

The formative evaluation process included an evaluation questionnaire. The goal of this study is to obtain feedback from university students about the first iteration of the researcher's implementation of a food recipe website targeted for students. The questions included assessing the website's design and what functionalities should be prioritized in building second iteration of the website implementation. Such questions included what shortcut links should be added and how featured recipes in the homepage should be ranked. The questionnaire also included the SUS to obtain an overall rating of the usability of the prototype perceived by the users. The evaluation questionnaire was analyzed using descriptive statistics, including mean, median and standard deviation [Background - 2.8]. These statistics would help support the justification for the updated list of requirements [Appendix - G].

6.2.3.2 Formative Evaluation Results

Students sincerely appreciated the UI design and search for recipes with maximum cooking time. Based on the questionnaire used during requirements gathering, the median cooking time most students are willing to cook is between 30-45 minutes. Therefore, students perhaps appreciated the filter of recipes based on maximum cooking time. In addition, 15/23 respondents thought shortcut links are at least somewhat useful for the users to find a certain category of recipes quickly. Deciding how featured recipes should be displayed was a strong topic of discussion. These featured recipes being be arranged according to popularity seems like the most viable option. However, most students (12/23) would appreciate a combination of popularity and highest rating. *"A combination of both: sometimes one ranking and 5 stars is less informative than 40 rankings with 4.5." - s21* . The full results of the evaluation questionnaire is covered in [Appendix - F.4].

The System Usability Scale (SUS) questions in the questionnaire particularly aimed to answer RQ#7 [Evaluation - 7.1]. From the evaluation questionnaire results shown in Table 6.1, analyzing the SUS [Background - 2.13] responses resulted in the average SUS score among the 23 respondents for my food recipe website is 78.9. Given the overall average SUS score is 68 [52], this may indicate that my first iteration of my food recipe website is good but could be further improved as shown in Table 2.1. It should be noted that the odd number questions in the SUS correspond to positive aspects of the system and even numbered questions correspond to negative aspects [51] where high scores in odd-numbered questions and low scores in even-numbered questions are good respectively. Therefore, a considerably low score is the usage of the system – feedback claiming the lack of recipes and features in the website may contribute to the relatively poor score. The 2 major overall outliers' scores are 22.5 and 32.5 respectively. One suggestion claimed *"there is no video corresponding to the instructions list - it should be in the form of tables to be more clear" - s6* Possibly those scores indicated they may have expected more advanced functionalities and interactive media in the website. The median score is 85, which is higher than the average because the measure does not take the outlier values into consideration. In addition, the overall standard deviation score is 18.457, where the data points are diversely spread out.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
S1	4	1	5	1	5	3	3	3	4	2	77.5
S2	4	1	5	1	5	2	5	1	5	1	95.0
S3	5	2	4	1	4	1	5	1	5	1	92.5
S4	3	3	4	1	3	4	5	2	2	1	65.0
S5	1	4	2	1	4	5	1	3	2	4	32.5
S6	4	2	4	1	3	3	4	2	5	2	75.0
S7	4	1	4	1	4	2	4	2	4	1	82.5
S8	4	1	5	1	4	2	5	1	4	1	90.0
S9	3	2	5	1	3	2	5	1	5	1	85.0
S10	1	1	5	1	5	1	5	1	5	1	90.0
S11	4	1	5	1	4	2	5	1	5	1	92.5
S12	4	1	4	1	4	1	4	1	4	1	87.5
S13	3	3	4	1	3	2	4	3	2	1	65.0
S14	2	1	5	1	3	2	5	2	4	2	77.5
S15	4	3	4	3	4	2	4	2	4	3	67.5
S16	5	1	2	1	5	1	5	3	4	1	85.0
S17	5	2	4	1	4	2	4	2	4	1	82.5
S18	4	1	4	1	2	3	5	2	4	2	75.0
S19	1	4	2	4	2	4	2	4	2	4	22.5
S20	2	1	5	1	5	1	5	1	5	1	92.5
S21	5	1	4	1	5	1	5	1	5	1	97.5
S22	4	1	5	1	4	2	5	1	5	1	92.5
S23	4	1	5	1	4	1	5	1	4	1	92.5
AVG	3.478	1.696	4.174	1.217	3.87	2.13	4.348	1.783	4.043	1.522	**78.9**
MEDIAN	4	1	4	1	4	2	5	2	4	1	**85**
STANDARD DEVIATION	1.247	0.997	0.962	0.719	0.899	1.076	1.047	0.883	1.042	0.926	**18.457**

Table 6.1: System Usability System Results from Formative Evaluation Questionnaire

6.3 Second Iteration

Website Link Deployed on University Servers: **http://s1840358vm.inf.ed.ac.uk:5000/**
Website Link for Summative Evaluation: **https://justcookstudent.herokuapp.com/**

6.3.1 Updated List of Requirements

Based from the feedback obtained from evaluation questionnaire, I created an updated list of requirements shown in [Appendix G]. This particularly includes embedding the shortcut links (R27) in the homepage, where users would find a certain category of recipes quickly. Other functionalities include filter recipes by estimated price per serving (R29) and obtaining recipes from video sources such as Youtube (R26). These functionalities were chosen to suit the university students' needs.

6.3.2 How Second Iteration Works

As the second round of implementation currently builds of the first iteration, the project structure therefore had to be more organized shown in Figure 6.11. The web scripts, Spoonacular API and helper modules, were moved to the folder 'web_scraping'. Figure 6.12 highlights the Python code that was added for also scraping the Tasty Website (R3). The 'Procfile' was used to deploy the web application on Heroku [85] - so university students could view the web application outside of the university networks for summative evaluation [Chapter 7]. In addition, the updated version of the website would be deployed for Project Day - refer to [Appendix - I] for the poster used to promote the website.

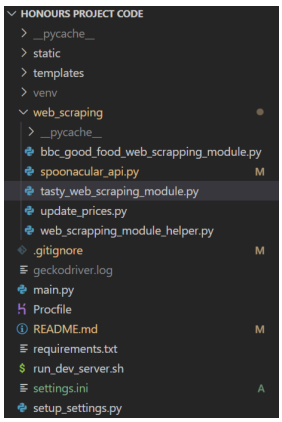

Figure 6.11: Updated Project Structure

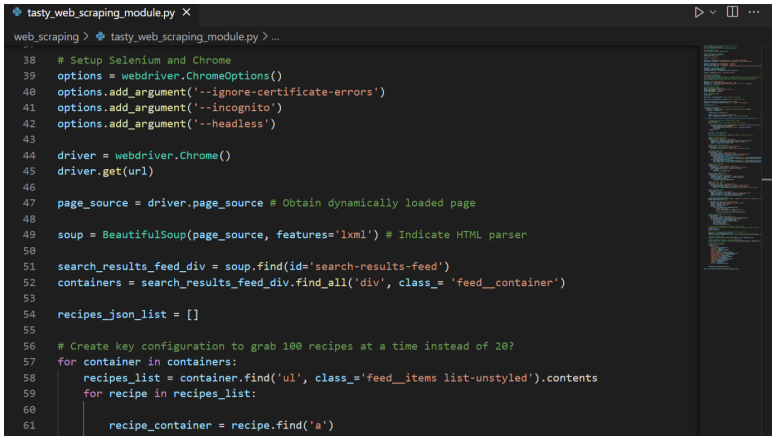

Figure 6.12: Web Scraping Code for Tasty Website

6.3.3 How Second Iteration Looks

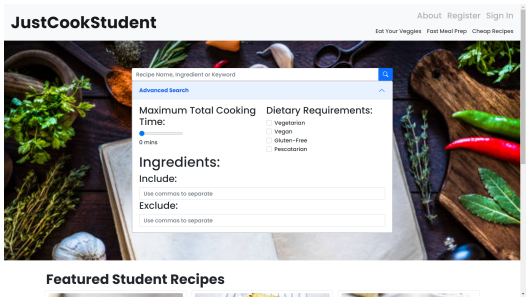

Figure 6.13: Updated Homepage

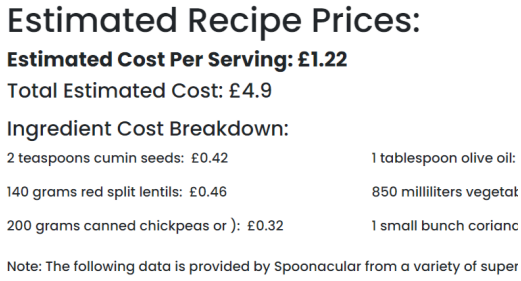

Figure 6.14: Estimated Price for a Recipe from Tasty Website

The additional functionalities implemented in the second phase was justified from the updated list of requirements [Appendix: G]. While the Homepage had subtle differences, the *"Dietary Requirements"* options are in the form of checkboxes instead of a dropdown list. This makes it more intuitive for the user to find recipes suitable to the student's dietary requirements shown in Figure 6.13. This functionality also respects Nielsen's Heuristic #3 - User Control & Freedom [Appendix A]. The functionality for quick shortcut links allows students to easily find a specific collection of recipes such as *"Eat Your Veggies"* or *"Fast Meal Prep"* (R27). The second iteration implicitly stated the website would contain additional recipes. Therefore I had to create another script called *"quick"* food recipes from the Tasty website URL: *https://tasty.co/search?q=quick* (R3). The "Quick" recipes collection were justified from the initial questionnaire where the median cooking time most students are willing to cook is between 30-45 minutes [Requirements - 4.7.1. I also implemented functionality to ensure recipes can be sorted by highest rating, number of ratings and cooking time (R5, R28). Using the Spoonacular API, I implemented the functionality to showcase the estimated total recipe price, price per serving for each recipe, and ingredient cost breakdown (R23) shown in Figure 6.14.

Chapter 7

Evaluation

The following chapter explains the study protocols, analysis and results for the summative evaluation study for the food recipe web application. The study was conducted in the combined format of a focus group and stakeholder walkthrough [Background - 2.8]. While I conducted the formative evaluation shown in Section # 6.2.3, this second evaluation phase facilitates a further understanding of the usability of my website and how my website creates a potential impact on their cooking habits. In addition, the study gives an insight in comparing students' perceived usage of my website relative to other food recipe websites.

7.1 Study Protocols

The following chapter aims to answer Research Question #6: What are the students' perception about the developed system with regards to:

1. usability
2. potential impact on their cooking habits, in general and compared to existing food recipe websites?

The evaluation studies were conducted over a university account in Zoom, which allowed the audio and video recording. A Doodle poll was sent to interested participants, who offered to participate from the initial evaluation questionnaire and other interested students to participate recruited by word of mouth. They requested which timeslots would suit them the most, where the timeslot with the most votes would be selected.

Due to the limited time constraints and the elongated time duration allocated for the two phases of implementation, there were few participants available for the final evaluation process. I fortunately recruited 11 participants successfully for the final evaluation study, all whom are are University of Edinburgh students. Before the study formally started, the participants were sent the updated Participant Information Sheets before the study, and filled out the respective consent forms for the evaluation study before participating [Appendix - J]. Recording by Zoom allowed me to collect data for the data analysis.

Each session started with a quick focus group, where the researcher would asked each student warm-up questions about experience with food recipe websites. The shift of focus would go towards a stakeholder walkthrough. The researcher defined what tasks were to be completed on the website prototype, where the website link was given via chat. Participants would then be required to complete the tasks on the prototype and share their progress with them (40 minutes). Each participant would be asked to share their feedback for the website implementation, and discuss suggestions with the rest of the group. Finally, the participants would be asked as part of a focus group to share their views on the potential of the website for impacting student cooking habits (10 minutes). The leading question: **"How incentivized would you be to use this website in comparison with other food recipe websites that you normally use?** aimed to specifically answer Research Question #6. Finally users were provided a link to a Microsoft Forms form where they would fill in a System Usability Scale questionnaire on the general usability of the prototype (5 minutes).

7.2 Analysis

The recordings from the sessions were transcribed using the captions created by Zoom. The transcripts were then analyzed using NVivo [Background - 2.10] by Thematic analysis with a top-down coding approach, as the questions were driven by specific research questions in the study [Introduction - 1.2] [65]. Analyzing the SUS questionnaire was based from the SUS Acceptability Rating Table [Background - 2.8]. The list of nodes generated in the evaluation session can be found in Appendix J.3.

7.3 Results

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
S1	4	1	5	1	4	1	5	1	5	1	95
S2	4	2	4	1	3	3	4	2	4	1	75
S3	4	1	5	1	5	1	5	1	4	1	95
S4	4	2	5	1	4	1	5	2	4	2	85
S5	5	2	5	1	5	1	5	1	5	1	97.5
S6	4	1	4	2	4	2	4	2	5	1	82.5
S7	4	2	4	1	4	2	4	2	4	2	77.5
S8	4	3	4	2	3	2	4	3	4	1	70
S9	4	2	4	1	4	1	5	1	4	2	85
S10	4	2	4	1	4	2	3	2	5	1	80
S11	4	1	4	1	4	2	5	2	4	1	85
AVG	4.091	1.727	4.364	1.182	4	1.636	4.455	1.727	4.364	1.273	**84.318**
MEDIAN	4	2	4	1	4	2	5	2	4	1	**85**
STANDARD DEVIATION	0.287	0.617	0.481	0.385	0.603	0.643	0.656	0.617	0.481	0.445	**8.332**

Table 7.1: System Usability System Results from Summative Evaluation Questionnaire

As mentioned the System Usability Scale (SUS) is an excellent evaluation tool for assessing the food recipe website's overall usability. I created a SUS table for the evaluation study shown in 7.1. The slight improvement in the overall mean SUS score from 78.9 to 84.318 was pleasing. The median score remained at 85 due to the lack of outlier values. It should be noted that the standard deviation value is at 8.332 compared to 18.457 previously due to the small number of participants in the final evaluation

study. The score from 3.478 to 4.091 for the average question regarding ”I think that I would like to use this system frequently.” was a significant improvement - suggesting users would want to start using this website.

7.3.1 General

All 11/11 participants claimed they would use this recipe website. According from the transcribed audio recordings supplemented by the Zoom video recordings, 6 of those 11 would use the website at least once per week to experiment further with their cooking habits: *”I mean i’m getting pretty tired of making the same stuff and I would say a good once a week cooking on your site – s11”*

7.3.2 Potential Impact on their Cooking Habits Relative to Existing Food Recipe Websites (RQ#6)

1. **Advanced Filter Search**: In total there are 4 out of 11 participants who appreciated this functionality; they in particularly found filtering recipes by ingredients useful.

   ”you can exclude or include certain ingredients is super helpful - just really clearing out the fridge and run these experiments.” – s11

2. **Simple to Understand**: There are 4 out of 11 participants in total who believe that this attribute makes this food recipe website unique in particular.

   ”it’s quite straightforward and has functionalities targeted towards university students. I think those are useful especially when they’re learning how to cook” – s5

3. **Estimated Price Functionality** - in total there are 4 out of 11 participants who supported this functionality.

   ”finding the estimated price is really helpful; like you can see how much you’re spending for the meal” - s6

There were a variety of responses regarding what aspects made my website more distinct than other websites as mentioned due to the unique functionalities mentioned above. In particular, 3 out of 11 participants purposed they would use my website more than BBCGoodFood due to the advanced filtered search functionality.

”I would I would use it more than BBCGoodFood because of the advanced filter search functionality, especially with search recipes based on both including and excluding ingredients. – s9”

7.4 Conclusion

While the food recipe website received generally positive feedback, but there exists areas of improvement to be found. From the formative and summative evaluation, there are additional changes to be made as shown in the Results.

Chapter 8

Discussions, Future Work and Conclusions

8.1 Discussions

Given the large number of requirements [RQ - 4.8], figuring out what features to implement in my website were challenging. Obtaining an agile approach to development facilitated the progress of the web application much faster due to the fast constructive feedback I received from the questionnaire and design workshops. Conducting 2 rounds of implementation along with 2 rounds of evaluation from those requirements were time-consuming but required to ensure that students would want to use the website.

Certain functionalities that students wanted were not supposedly straightforward to implement. For example, obtaining the price breakdown for recipes and its corresponding ingredients, was more tricky than expected. I had to research food recipe website APIs and compare and constrast their functionalities. In addition, many APIs such as Tesco Labs were depreciated which made implementing some functionalities more challenging than expected.

Given the lessons I learned during the project process, I would started the implementation earlier as I had little prior knowledge in web scraping and writing the Python code for extracting data from recipe websites took longer than expected as the recipes would require multiple attributes such as list of ingredients and preparation steps. The time-constraints and technical difficulties encountered created some limitations for this project. I have proposed my solutions in the [Future Work - 8.2].

8.2 Future Work

Given the website is currently a prototype, I would integrate ”web crawling” and ”web scraping” together using Scrapy to automatically navigate web pages to extract food recipe information rather than just from one or two food recipe websites [75]. Additionally mentioned earlier, I would use more powerful server technologies such

as Node.JS instead of Flask given the performance limitations as addressed in Section 6.1.2.

Based from the final evaluation, implementing a searchbar which handles typing errors would be a next step: *"Having some sort of natural language processing things like typos if you like misspelled vegetables in the search-bar" – s5.* Additionally from the updated list of requirements shown in [Appendix - G], I would implement Rs#22-24,26-29 as future work. To further strengthen my targeted users' interests in my food recipe website, I would conduct more evaluation studies with users, as I had a small number of participants. Such studies may include evaluating the website's performance using Google Chrome Developer Tools. Given the large number of students interested in this project, this project could be potentially commercialized to more university students outside of Edinburgh.

8.3 Conclusions

During this study, I designed, implemented and evaluated a food recipe website targeted for university students. Literature review was firstly researched on a large variety of topics such as university students' perceptions of cooking and barriers to cooking, and existing food recipe websites. I then gathered requirements from the students themselves by conducting a questionnaire which received 87 responses and participatory design workshops with ten students to draw out the designs for the food recipe website. I then sketched the design prototypes and created the static and dynamic designs for the website along with creating two iterations of the food recipe website implementation. Finally, I did two rounds of evaluation which included a questionnaire and two stakeholder walkthroughs respectively. The overall feedback was positive and some students showed interest in using this food recipe website, even more than other websites especially BBCGoodFood.

8.3.1 RQ1: Regarding University students: What factors affect students' cooking perceptions? Why are university students hesitant to cook?

The answer is explained in Section 4.7.1. Factors included their food spending budget and amount of time and frequency they spend to cook. Students are hesitant to cook mainly due to academic commitments, short life of food ingredients, and planning what to eat.

8.3.2 RQ2: What online and offline resources do students use to cook food recipes?

The answer is explained in Section 4.7.1. Regarding offline sources, most participants picked "Family and/or Friends". While there were a number of mixed results, Youtube and BBCGoodFood were especially popular to cook food recipes. Using Tasty and search engines, particularly Google, were honourable mentions.

8.3.3 RQ3: What aspects do university students like and dislike about online food recipe sources?

The answer is explained in Section 4.7.1. Students appreciated that online food recipe sources were easy to follow and understand. However, they disliked that they consisted of inaccurate/inconsistent measurements and frustrated with either too many ingredients or lack of substitute ingredients in the recipes.

8.3.4 RQ4: What features and improvements would university students appreciate in a food recipe website?

The answer to this question is elaborated further in Section 4.7.2. These features and improvements that students would want in such a website are addressed in the list of requirements shown in Table 4.1.

8.3.5 RQ5: How should a food recipe website targeted for university students be designed?

The answer to this question was elaborated in Section 4.7.2. The participatory design workshops created perspectives on how the food website should be designed using sketches and feedback.

8.3.6 RQ6: How should a food recipe website targeted for university students be implemented?

The answer to this question was briefly mentioned in the Design Chapter 5 and further explained in Implementation Chapter 6. Python would be used to web scrape recipes from BBCGoodFood and Tasty websites. Flask would be the web framework and MongoDB is the database tool which would store the recipes. The order of the functionalities implemented would be justified by the list of requirements in both iterations and other factors.

8.3.7 RQ7: What are the students' perception about the developed system with regards to: usability and potential impact on their cooking habits, in general and compared to existing food recipe websites?

The question was answered in both the formative evaluation [Section 6.2.3] and summative evaluation [Chapter 7]. Students' perceptions of the system's usability was measured by the System Usability Scale (SUS). The slight improvement of the average overall usability score from 78.9 to 84.318 showed the possibility of strong user interest. In addition, the students would use my website more than other food recipe websites such as BBCGoodFood, mainly due to the search with advanced filters functionality.

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Appendix A

Heuristics

A.1 Nielsen's Heuristics

1. Visibility of System Status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error Prevention
6. Recognition rather than Recall
7. Flexibility and Efficiency of Use
8. Aesthetic and minimalist design
9. Help users recognize, diagnose, and recover from errors
10. Help and Documentation

A.2 Gestalt Principles

1. Proximity
2. Closure
3. Similarity
4. Continuity
5. Figure / Ground
6. Symmetry and Order
7. Organization

Appendix B

Design Workshop Screenshot Images

- TBC

Appendix C

Initial Questionnaire

C.1 Participant Consent Form

Participant number:_____

Participant Consent Form

Project title:	Personalized Food Recipe Platform for University Students
Principal investigator (PI):	Cristina Andriana Alexandru
Researcher:	Justin Howe
PI contact details:	Cristina.Alexandru@ed.ac.uk

By participating in the study, you agree that:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1.	I allow my data to be used in future ethically approved research.	☐ **Yes**	☐ **No**
2.	I agree to take part in this study.	☐ **Yes**	☐ **No**

Name of person giving consent	Date dd/mm/yy	Signature
_____	_____	_____
Name of person taking consent	Date dd/mm/yy	Signature
_____	_____	_____

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C.2 Participant Information Sheet

Participant Information Sheet for Gathering Requirements

Project title:	Personalized Food Recipe Platform for University Students
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Justin Howe
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/11901. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The main researcher of this study is Justin Howe, who is a final year undergraduate student in the University of Edinburgh School of Informatics. Cristina Adriana Alexandru is his supervisor. This study is conducted as part of an honours undergraduate project.

What is the purpose of the study?

The goal of this study is to learn about the students' characteristics and needs for a food recipe website, including their preferred cuisines and dietary requirements. In addition, it would also address why students are difficult to appease for building a web application for generating useful recipes, and what students consider could be improved in the design of recipe websites meant for them. This collected information would be then utilized to help envision the design and implementation of a web application for cooking recipes targeted towards university students.

Why have I been asked to take part?

As a university student with multiple deadlines looming, juggling other responsibilities, such as keeping fit and maintaining friendships during university can be challenging. Therefore, students could be more resistant to cook, let alone spend time and effort deciding what to cook. Students may be less willing to create weekly meal plans for themselves, and eating out/getting food delivered may be infeasible.

Therefore, we want to create a viable solution that would help busy university students to make cooking easier yet interactive using smart web technology.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

We will provide you with a short questionnaire on Microsoft Forms, which will take you between five and ten minutes to complete. In this questionnaire, we will ask some questions about your background, your personal attitude towards cooking, and barriers to cooking and eating healthily. Additional questions include what food recipe websites designed for university students (if you use any) may be lacking and possible suggestions for improvement. The final question would kindly ask you if you would like to participate in an optional workshop.

Are there any risks associated with taking part?

There are no significant risks associated with the participation of this study. Your studies and progression will not be affected. Your feedback and answers will remain strictly confidential and follow the relevant Data Protection Laws. No compensation will be provided for participation in this study.

Are there any benefits associated with taking part?

Your contribution, if you choose to participate, will help to generate a more effective web application for cooking recipes targeted for university students.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized. We will remove any

information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team. All electronic data will be stored on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint). Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)
If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Justin Howe (s1840358@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Justin Howe (s1840358@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

C.3 Questions

Personalized Recipe Food Platform for University Students Survey

This study is part of a undergraduate project. For more information, please refer to this link:
Participant Information Sheet: https://uoe-my.sharepoint.com/:w:/g/personal/s1840358_ed_ac_uk/EQvwKsH8SVhKhtwUM7YXOMoBSfJ-FSp5vAf7wFzOah2_IA?e=flOxaD (https://uoe-my.sharepoint.com/:w:/g/personal/s1840358_ed_ac_uk/EQvwKsH8SVhKhtwUM7YXOMoBSfJ-FSp5vAf7wFzOah2_IA?e=flOxaD)

Please answer this 5-10 minute to the best of your knowledge. Your help will be sincerely appreciated. This information would help to generate a more effective web application for cooking recipes targeted for university students.

This study is certified according to the Informatics Research Ethics Process, RT number 2019/11901.

* Required

* This form will record your name, please fill your name.

General

1. If you proceed with this survey, you agree with the following statements:
   - I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
   - My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
   - I consent to my anonymised data being used in academic publications and presentations.
   - I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.
   - I allow my data to be used in future ethically approved research.
   - I agree to take part in this study.

   ◯ Yes

   ◯ No

2. If any, what are your dietary requirements? (Select all that apply) *

   ☐ Lactose-Free

   ☐ Gluten-Free

   ☐ Vegetarian

   ☐ Vegan

   ☐ Halal

   ☐ None

   ☐ Other

3. If you have picked "Other", please specify below:

4. How much do you approximately spend on food on a **weekly** basis (GBP)?
(This includes buying groceries, food delivery and eating out) *

- ◯ 0-30
- ◯ 30-60
- ◯ 60-90
- ◯ 90-120
- ◯ 120+

5. Do you cook? *

- ◯ Yes
- ◯ No

6. Would you like to (be able to) cook? *

- ◯ Yes
- ◯ No

7. How often do you cook? *

- ◯ Once a month
- ◯ A few times a month
- ◯ Once a week
- ◯ A few times a week
- ◯ Every day

8. On average how long are you willing to cook in a day? [Minutes] *

- ◯ 0-15
- ◯ 16-30
- ◯ 30-45
- ◯ 45-60
- ◯ 60+

Personal Attitudes

9. Express your agreement to the following statements on healthy eating: *

	Strongly Agree	Agree	Disagree	Strongly disagree
Cooking correlates to necessarily cooking healthily	◯	◯	◯	◯
Home preparation is healthier	◯	◯	◯	◯
The food choices in what I eat matter	◯	◯	◯	◯
Obtaining a balanced diet is a priority	◯	◯	◯	◯
Regularly eating vegetables and fruits (5 portions a day) is important	◯	◯	◯	◯
Eating at home correlates to higher consumption of fruit and vegetables	◯	◯	◯	◯
I take nutrition labels into account of what I eat	◯	◯	◯	◯
I avoid eating foods which contain trans-fats (such as junk food)	◯	◯	◯	◯
Keeping my salt consumption low is important to me	◯	◯	◯	◯
Keeping my sugar consumption low is important to me	◯	◯	◯	◯
I eat about 2 portions of fish (including 1 portion of oily fish) a week	◯	◯	◯	◯
Starchy foods (such as rice, bread and potatoes) count towards approximately slightly more than 1/3 of my diet	◯	◯	◯	◯
I pay attention to my calories intake	◯	◯	◯	◯
When cooking meals, I attempt to make healthier versions of meals (such as oven baking chips instead of deep-frying)	◯	◯	◯	◯

10. Express your agreement to the following statements on cultural influences on eating and cooking: *

	Strongly agree	Agree	Disagree	Strongly disagree
I enjoy eating with friends and family	◯	◯	◯	◯
Eating with friends and/or family is more enjoyable than eating alone	◯	◯	◯	◯
Social media influences the way I eat	◯	◯	◯	◯
Television influences the way I eat	◯	◯	◯	◯
My family and/or friends have influenced me to eat healthily	◯	◯	◯	◯
My family and/or friends have influenced me to cook	◯	◯	◯	◯
I enjoy eating a variety of foods from all over the world	◯	◯	◯	◯
I am willing to try new foods	◯	◯	◯	◯

Barriers to Cooking and Eating Healthily

11. What factors may prevent you from cooking? *

- [ ] Too little time due to academic commitments
- [ ] Buying groceries is expensive
- [ ] Lack of food preparation / cooking skills
- [ ] Short shelf life of ingredients and/or food
- [ ] Too little time due to job committment
- [ ] Lack of time due to hobbies
- [ ] Lack of willpower
- [ ] Lack of cooking facilities
- [ ] Inadequate space for cooking
- [ ] Planning what to eat is a hassle
- [ ] I prefer eating out
- [ ] Others cook for me
- [ ] Lack of tools and utensils for cooking

Food Recipe Platform Websites / Online Food Recipe Sources

12. Where do you / would you look up recipes? (Select all that apply) *

- [ ] Youtube
- [ ] Pinterest
- [ ] Instagram
- [ ] Facebook Groups
- [ ] Other Forms of Social Media
- [ ] BBCGoodFood
- [ ] The Food Network
- [ ] Epicurious
- [ ] Recipe cookbooks
- [ ] Food magazines
- [ ] Meal-kits / Food subscription boxes (Examples include Gousto and HelloFresh)
- [ ] Family and/or Friends
- [ ] Cooking blogs
- [ ] Other

13. If you have picked 'Other Forms of Social Media' or 'Other' option in the previous question, please elaborate further.

14. Which websites have you used to find recipes with ingredients you already have in the kitchen? *

- [ ] Supercook
- [ ] Cookpad
- [ ] Epicurious
- [ ] BigOven
- [ ] Tasty
- [ ] AllRecipes Dinner Spinner
- [ ] Other
- [ ] None

15. If you have selected 'Other' in the previous question, please list which websites you use:

16. If you picked any online food recipe sources in the previous questions, or have tried any before, what do you / did you like about them?

17. If you picked any online food recipe sources in the previous questions, or have tried any before, what do you / did you dislike about them?

18. Please express your agreement with the following statements regarding online food recipe sources: *

	Strongly Agree	Agree	Disagree	Strongly Disagree
Certain recipes are too time-consuming	◯	◯	◯	◯
Recipe steps are not detailed enough	◯	◯	◯	◯
Recipes have too many ingredients	◯	◯	◯	◯
Lack of integration with smaller food suppliers (local markets, smaller supermarkets etc)	◯	◯	◯	◯
Recipes ingredients are too expensive	◯	◯	◯	◯
Lack of substitute ingredients	◯	◯	◯	◯
Lack of recipe recommendations	◯	◯	◯	◯
Buying the ingredients for desired recipes takes up too much time	◯	◯	◯	◯
The recipes in the website are something I would rather not cook	◯	◯	◯	◯

19. In your opinion, are food recipe websites good enough for university students? Please elaborate why. *

20. In your opinion, how useful are food recipe websites for university students? Please elaborate why. *

21. Are you willing to participate in a voluntary workshop? The workshop will consist of a 30-45 minute session about designing an improved personalized recipe food platform for university students. (If so, please provide your university email address)

Appendix D

Initial Design Workshops

D.1 Participant Information Sheet

Participant Information Sheet for Food Recipe Website Design Workshop

Project title:	Personalized Food Recipe Platform for University Students
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Justin Howe
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/11901. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The main researcher of this study is Justin Howe, who is a final year undergraduate student in the University of Edinburgh School of Informatics. Cristina Adriana Alexandru is his supervisor. This study is conducted as part of an honours undergraduate project.

What is the purpose of the study?

After understanding the students' characteristics and their needs for a food recipe website targeted for university students in an initial study, this study now aims to involve students in a design workshop to help translate those requirements into a prototype. This study actively involves the students in the design process to ensure the food recipe website would be usable and support their needs. In addition, it will help to prioritize what features we would need to implement first.

Why have I been asked to take part?

As a university student with multiple deadlines looming, juggling other responsibilities, such as keeping fit and maintaining friendships during university can be challenging. Therefore, students could be more resistant to cook, let alone spend time and effort deciding what to cook. Students may be less willing to create weekly meal plans for themselves, and eating out/getting food delivered may be infeasible.

Therefore, we want to create a viable solution that would help busy university students to make cooking easier yet interactive using smart web technology.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

This study would be conducted as an online study on Zoom. A Doodle poll will be sent to interested participants, who offered to participate as part of the previous questionnaire, requesting which timeslot would suit them the most. The timeslot with the most votes would be selected.

This study would take a total duration of approximately 1 hour to complete. The study will first begin with a focus group which lasts for 10 minutes, where the facilitator would ask you warm-up questions about your experience with food recipe websites, as well as what you particularly like and dislike about them. An online collaborative note taking platform called Padlet would be used to take notes. The participants would then vote on the features they would like to see in a food recipe website targeted for students.

During the next part of the session, which would last approximately 35 minutes, the researcher would then show some example interfaces of food recipe website. Users would then individually draw out prototypes of web pages including the top 3 voted features concluded on in the first part of the study. After 20-25 minutes are up, they would then send their prototypes to the researcher by email. Each participant would be asked to describe their prototype with the researcher sharing their drawings on the screen.

The final part of the session would entail conducting another focus group for the last 15 minutes. The participants would be asked to express their opinions on the prototypes presented. The researcher would also prompt them with example designs from existing food recipe websites. Finally, the participants would conclude on their favourite features and the order in which they should be implemented.

Are there any risks associated with taking part?

There are no significant risks associated with the participation of this study. Your studies and progression will not be affected. Your feedback and answers will remain strictly confidential and follow the relevant Data Protection Laws. No compensation will be provided for participation in this study.

Are there any benefits associated with taking part?

Your contribution, if you choose to participate, will help to generate a more effective web application for cooking recipes targeted for university students.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized. We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team. All electronic data will be stored on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint). Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact

inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Justin Howe (s1840358@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Justin Howe (s1840358@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

D.2 Initial Design Workshop Structure

Initial Design Workshop (Focus Group) Structure:

Before the Design Workshop:

Warmup Questions (15 mins):

- Have you ever used food recipe websites? If so, which?

After this question is asked, tell participants that I will show some example interfaces of food recipe websites first.

- **How useful are these food recipe websites for you?**
- **What was your experience with these websites? Please outline both pros and cons.**
- What features would you like to have in food recipe websites? So that they would be more useful for you.
    - Using **Padlet** to get participants to add virtual sticky notes to enter features they would like to see in a food recipe website targeted for students. Participants would then vote for the top 2 features.
- Question: Vote on the Padlet which are your top 2 preferred features?

During the Design Workshop (35 mins):

Next, I would like you to individually draw out prototypes of web pages on paper which include the top 2 highest-voted features concluded in the first part of the study. Be creative about this process and I would like to give you 20 minutes.

Please take a picture of the interface prototype on your phone and send it to my university student email (s1840358@ed.ac.uk).

After the following 20-25 minutes are up, participants would then send figures on paper to email; and then the designed prototypes will be shown and discuss them with what they already like.

I will now share the prototypes on the screen, please describe them in your own words.

After Design Process in Workshop (10 mins):

- What were your favorite design elements in the prototypes you have seen?
- What was your opinion of feature X?
- What were your favorite features and which order they should be implemented?

D.3 Design Workshop Prototype Drawings

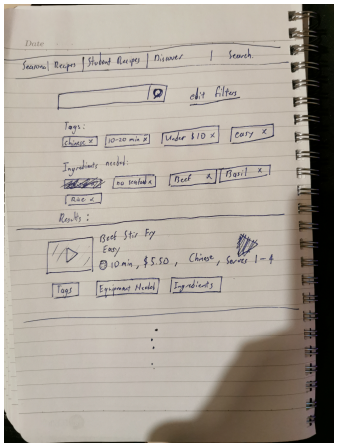


Figure D.1: Design Prototype #1

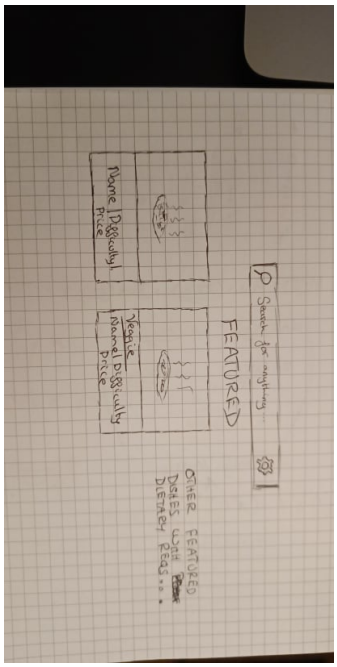


Figure D.2: Design Prototype #2

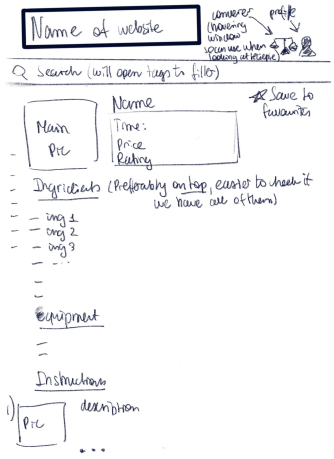
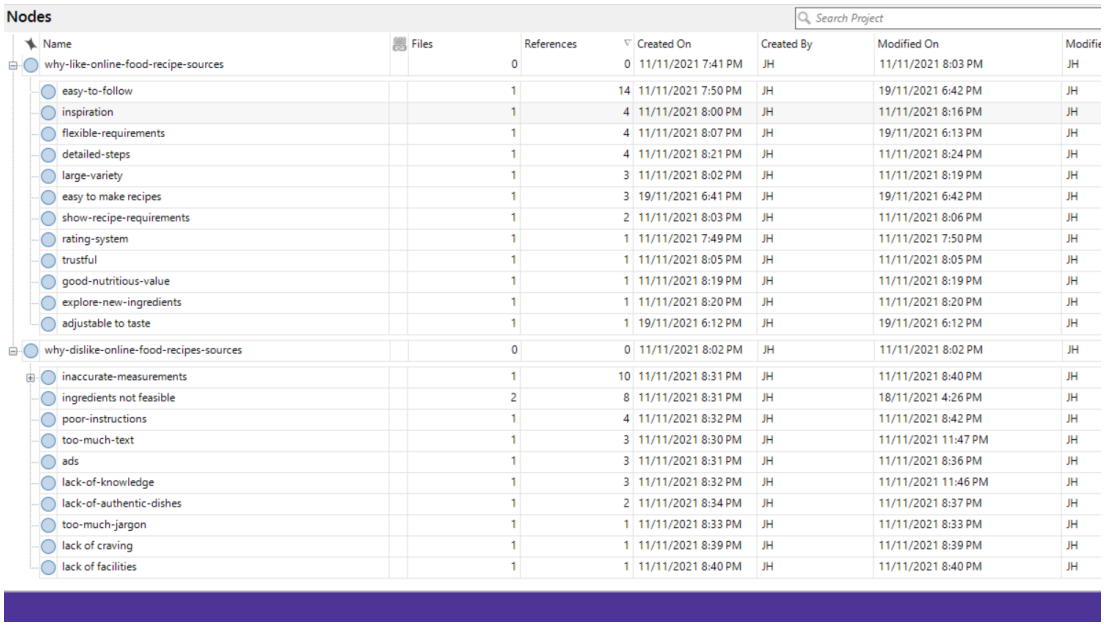


Figure D.3: Design Prototype #3

Appendix E

Requirements Gathering Data Analysis - NVivo

E.1 Initial Questionnaire



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Search Project

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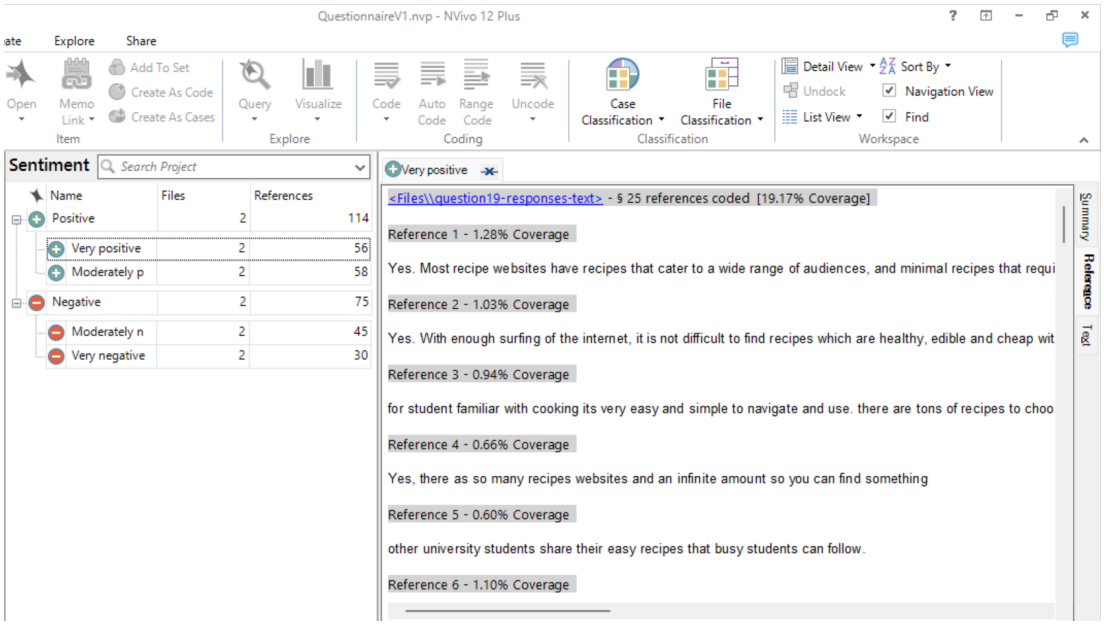
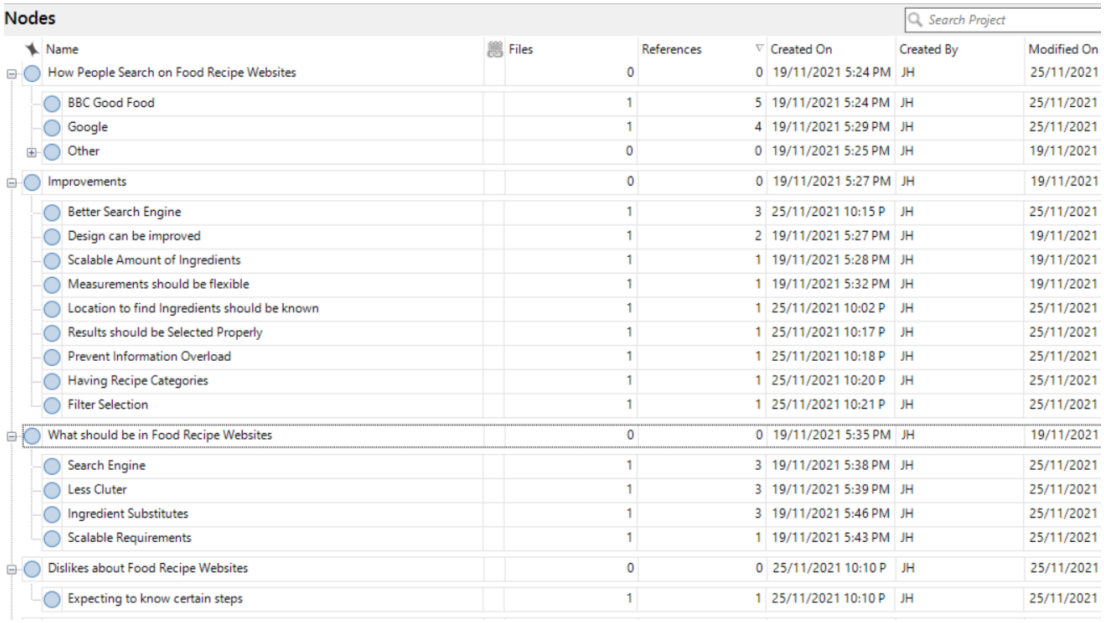
why-like-online-food-recipe-sources	0	0	11/11/2021 7:41 PM	JH	11/11/2021 8:03 PM	JH
easy-to-follow	1	14	11/11/2021 7:50 PM	JH	19/11/2021 6:42 PM	JH
inspiration	1	4	11/11/2021 8:00 PM	JH	11/11/2021 8:16 PM	JH
flexible-requirements	1	4	11/11/2021 8:07 PM	JH	19/11/2021 6:13 PM	JH
detailed-steps	1	4	11/11/2021 8:21 PM	JH	11/11/2021 8:24 PM	JH
large-variety	1	3	11/11/2021 8:02 PM	JH	11/11/2021 8:19 PM	JH
easy to make recipes	1	3	19/11/2021 6:41 PM	JH	19/11/2021 6:42 PM	JH
show-recipe-requirements	1	2	11/11/2021 8:03 PM	JH	11/11/2021 8:06 PM	JH
rating-system	1	1	11/11/2021 7:49 PM	JH	11/11/2021 7:50 PM	JH
trustful	1	1	11/11/2021 8:05 PM	JH	11/11/2021 8:05 PM	JH
good-nutritious-value	1	1	11/11/2021 8:19 PM	JH	11/11/2021 8:19 PM	JH
explore-new-ingredients	1	1	11/11/2021 8:20 PM	JH	11/11/2021 8:20 PM	JH
adjustable to taste	1	1	19/11/2021 6:12 PM	JH	19/11/2021 6:12 PM	JH
why-dislike-online-food-recipes-sources	0	0	11/11/2021 8:02 PM	JH	11/11/2021 8:02 PM	JH
inaccurate-measurements	1	10	11/11/2021 8:31 PM	JH	11/11/2021 8:40 PM	JH
ingredients not feasible	2	8	11/11/2021 8:31 PM	JH	18/11/2021 4:26 PM	JH
poor-instructions	1	4	11/11/2021 8:32 PM	JH	11/11/2021 8:42 PM	JH
too-much-text	1	3	11/11/2021 8:30 PM	JH	11/11/2021 11:47 PM	JH
ads	1	3	11/11/2021 8:31 PM	JH	11/11/2021 8:36 PM	JH
lack-of-knowledge	1	3	11/11/2021 8:32 PM	JH	11/11/2021 11:46 PM	JH
lack-of-authentic-dishes	1	2	11/11/2021 8:34 PM	JH	11/11/2021 8:37 PM	JH
too-much-jargon	1	1	11/11/2021 8:33 PM	JH	11/11/2021 8:33 PM	JH
lack of craving	1	1	11/11/2021 8:39 PM	JH	11/11/2021 8:39 PM	JH
lack of facilities	1	1	11/11/2021 8:40 PM	JH	11/11/2021 8:40 PM	JH



E.2 Initial Design Workshops



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Search Project

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How People Search on Food Recipe Websites	0	0	19/11/2021 5:24 PM	JH	25/11/2021
BBC Good Food	1	5	19/11/2021 5:24 PM	JH	25/11/2021
Google	1	4	19/11/2021 5:29 PM	JH	25/11/2021
Other	0	0	19/11/2021 5:25 PM	JH	19/11/2021
Improvements	0	0	19/11/2021 5:27 PM	JH	19/11/2021
Better Search Engine	1	3	25/11/2021 10:15 P	JH	25/11/2021
Design can be improved	1	2	19/11/2021 5:27 PM	JH	19/11/2021
Scalable Amount of Ingredients	1	1	19/11/2021 5:28 PM	JH	19/11/2021
Measurements should be flexible	1	1	19/11/2021 5:32 PM	JH	19/11/2021
Location to find Ingredients should be known	1	1	25/11/2021 10:02 P	JH	25/11/2021
Results should be Selected Properly	1	1	25/11/2021 10:17 P	JH	25/11/2021
Prevent Information Overload	1	1	25/11/2021 10:18 P	JH	25/11/2021
Having Recipe Categories	1	1	25/11/2021 10:20 P	JH	25/11/2021
Filter Selection	1	1	25/11/2021 10:21 P	JH	25/11/2021
What should be in Food Recipe Websites	0	0	19/11/2021 5:35 PM	JH	19/11/2021
Search Engine	1	3	19/11/2021 5:38 PM	JH	25/11/2021
Less Cluter	1	3	19/11/2021 5:39 PM	JH	25/11/2021
Ingredient Substitutes	1	3	19/11/2021 5:46 PM	JH	25/11/2021
Scalable Requirements	1	1	19/11/2021 5:43 PM	JH	25/11/2021
Dislikes about Food Recipe Websites	0	0	25/11/2021 10:10 P	JH	25/11/2021
Expecting to know certain steps	1	1	25/11/2021 10:10 P	JH	25/11/2021

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Search Project

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Less Cluter	1	3	19/11/2021 5:39 PM	JH	25/11/2021 10:18 PM
Ingredient Substitutes	1	3	19/11/2021 5:46 PM	JH	25/11/2021 10:23 PM
Scalable Requirements	1	1	19/11/2021 5:43 PM	JH	25/11/2021 10:16 PM
Dislikes about Food Recipe Websites	0	0	25/11/2021 10:10 P	JH	25/11/2021 10:10 PM
Expecting to know certain steps	1	1	25/11/2021 10:10 P	JH	25/11/2021 10:11 PM
Likes about Food Recipe Websites	0	0	25/11/2021 10:13 P	JH	25/11/2021 10:13 PM
Showing End Result	1	1	25/11/2021 10:13 P	JH	25/11/2021 10:13 PM
Search Engine	1	1	25/11/2021 10:13 P	JH	25/11/2021 10:13 PM
Favorite Design Elements in Food Recipe Websites	0	0	1/12/2021 4:22 PM	JH	1/12/2021 4:22 PM
Hover Feature	1	3	1/12/2021 4:23 PM	JH	1/12/2021 4:24 PM
Video	1	1	1/12/2021 4:23 PM	JH	1/12/2021 4:23 PM
Tags	1	1	1/12/2021 4:24 PM	JH	1/12/2021 4:24 PM
Clean Design Format	1	1	1/12/2021 4:25 PM	JH	1/12/2021 4:25 PM
Favorite Features for Food Recipe Websites	0	0	1/12/2021 4:27 PM	JH	1/12/2021 4:27 PM
Showcase of Utensils	1	4	1/12/2021 4:29 PM	JH	1/12/2021 4:32 PM
Good Recipe Overview	1	2	1/12/2021 4:29 PM	JH	1/12/2021 4:30 PM
Ensuring right amount of ingredients	1	1	1/12/2021 4:31 PM	JH	1/12/2021 4:31 PM
Search Engine	1	1	1/12/2021 4:31 PM	JH	1/12/2021 4:31 PM
Time to Cook including Prep	1	1	1/12/2021 4:32 PM	JH	1/12/2021 4:32 PM

Nodes

Search Project

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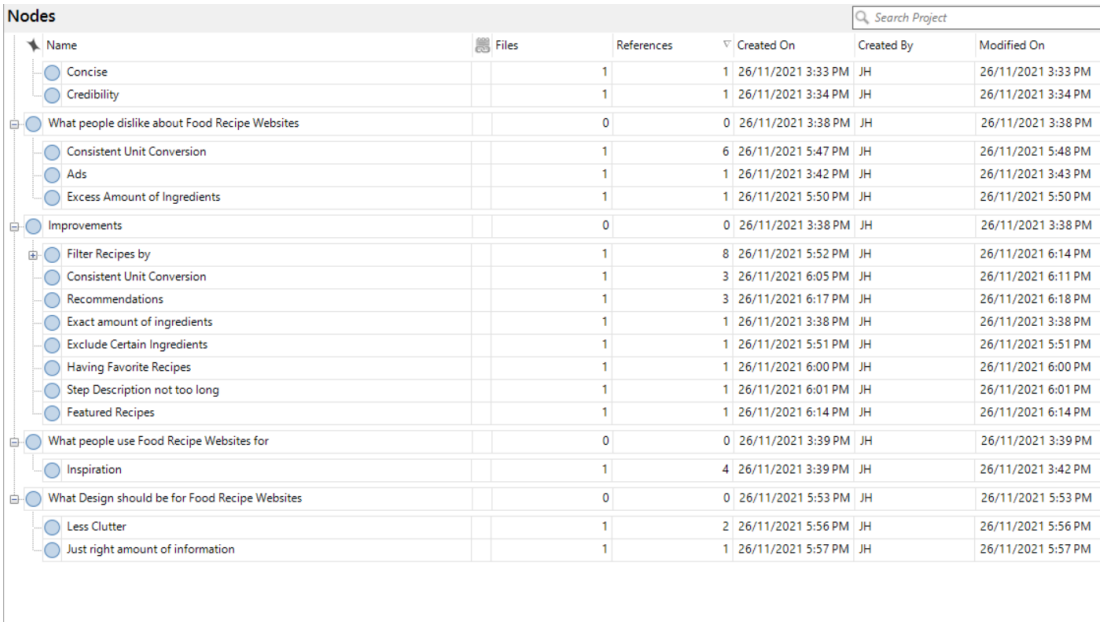
BBCGoodFood	1	4	26/11/2021 2:35 PM	JH	26/11/2021 2:45 PM
Jamie Oliver	1	1	26/11/2021 3:32 PM	JH	26/11/2021 3:32 PM
What people like about Food Recipe Websites	0	0	26/11/2021 2:36 PM	JH	26/11/2021 2:36 PM
Great diversity of recipes	1	3	26/11/2021 3:33 PM	JH	26/11/2021 3:41 PM
Less Scrolling	1	2	26/11/2021 2:37 PM	JH	26/11/2021 2:44 PM
Advanced Search Features	1	2	26/11/2021 3:38 PM	JH	26/11/2021 5:48 PM
Concise	1	1	26/11/2021 3:33 PM	JH	26/11/2021 3:33 PM
Credibility	1	1	26/11/2021 3:34 PM	JH	26/11/2021 3:34 PM
What people dislike about Food Recipe Websites	0	0	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Consistent Unit Conversion	1	6	26/11/2021 5:47 PM	JH	26/11/2021 5:48 PM
Ads	1	1	26/11/2021 3:42 PM	JH	26/11/2021 3:43 PM
Excess Amount of Ingredients	1	1	26/11/2021 5:50 PM	JH	26/11/2021 5:50 PM
Improvements	0	0	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Filter Recipes by	1	8	26/11/2021 5:52 PM	JH	26/11/2021 6:14 PM
Consistent Unit Conversion	1	3	26/11/2021 6:05 PM	JH	26/11/2021 6:11 PM
Recommendations	1	3	26/11/2021 6:17 PM	JH	26/11/2021 6:18 PM
Exact amount of ingredients	1	1	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Exclude Certain Ingredients	1	1	26/11/2021 5:51 PM	JH	26/11/2021 5:51 PM
Having Favorite Recipes	1	1	26/11/2021 6:00 PM	JH	26/11/2021 6:00 PM
Step Description not too long	1	1	26/11/2021 6:01 PM	JH	26/11/2021 6:01 PM
Featured Recipes	1	1	26/11/2021 6:14 PM	JH	26/11/2021 6:14 PM
What people use Food Recipe Websites for	0	0	26/11/2021 3:39 PM	JH	26/11/2021 3:39 PM



Nodes

Search Project

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Credibility	1	1	26/11/2021 3:34 PM	JH	26/11/2021 3:34 PM
What people dislike about Food Recipe Websites	0	0	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Consistent Unit Conversion	1	6	26/11/2021 5:47 PM	JH	26/11/2021 5:48 PM
Ads	1	1	26/11/2021 3:42 PM	JH	26/11/2021 3:43 PM
Excess Amount of Ingredients	1	1	26/11/2021 5:50 PM	JH	26/11/2021 5:50 PM
Improvements	0	0	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Filter Recipes by	1	8	26/11/2021 5:52 PM	JH	26/11/2021 6:14 PM
Consistent Unit Conversion	1	3	26/11/2021 6:05 PM	JH	26/11/2021 6:11 PM
Recommendations	1	3	26/11/2021 6:17 PM	JH	26/11/2021 6:18 PM
Exact amount of ingredients	1	1	26/11/2021 3:38 PM	JH	26/11/2021 3:38 PM
Exclude Certain Ingredients	1	1	26/11/2021 5:51 PM	JH	26/11/2021 5:51 PM
Having Favorite Recipes	1	1	26/11/2021 6:00 PM	JH	26/11/2021 6:00 PM
Step Description not too long	1	1	26/11/2021 6:01 PM	JH	26/11/2021 6:01 PM
Featured Recipes	1	1	26/11/2021 6:14 PM	JH	26/11/2021 6:14 PM
What people use Food Recipe Websites for	0	0	26/11/2021 3:39 PM	JH	26/11/2021 3:39 PM
Inspiration	1	4	26/11/2021 3:39 PM	JH	26/11/2021 3:42 PM
What Design should be for Food Recipe Websites	0	0	26/11/2021 5:53 PM	JH	26/11/2021 5:53 PM
Less Clutter	1	2	26/11/2021 5:56 PM	JH	26/11/2021 5:56 PM
Just right amount of information	1	1	26/11/2021 5:57 PM	JH	26/11/2021 5:57 PM

Appendix F

Formative Evaluation Questionnaire

F.1 Participant Consent Form

F.2 Participant Information Sheet

Participant Information Sheet for Evaluation Phase

Project title:	Designing and Implementing a Personalized Food Recipe Platform for University Students using Web Extraction Approaches
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Justin Howe
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/11901. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The main researcher of this study is Justin Howe, who is a final year undergraduate student in the University of Edinburgh School of Informatics. Cristina Adriana Alexandru is his supervisor. This study is conducted as part of an honours undergraduate project.

What is the purpose of the study?

The goal of this study is to obtain feedback from university students about the first iteration of the researcher's implementation of a food recipe website targeted for students. Such questions may include assessing the website's design and what aspects of the website should be improved. This collected information would be then utilized to create a second iteration of the researcher's implementation of the website.

Why have I been asked to take part?

As a university student with multiple deadlines looming, juggling other responsibilities, such as keeping fit and maintaining friendships during university can be challenging. Therefore, students could be more resistant to cook, let alone spend time and effort deciding what to cook. Students may be less willing to create weekly meal plans for themselves, and eating out/getting food delivered may be infeasible.

Therefore, we want to create a viable solution that would help busy university students to make cooking easier yet interactive.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

We will provide you with a short questionnaire on Microsoft Forms, which will take you between five and ten minutes to complete. In this questionnaire, we will ask some questions about usage of food recipe websites and assessing the researcher's design and implementation of the food recipe website prototype. A 10-item questionnaire (System Usability Scale – SUS) with five response options ranging from 'Strongly Agree' to 'Strongly Disagree' will also be shown in the questionnaire.

Are there any risks associated with taking part?

There are no significant risks associated with the participation of this study. Your studies and progression will not be affected. Your feedback and answers will remain strictly confidential and follow the relevant Data Protection Laws. No compensation will be provided for participation in this study.

Are there any benefits associated with taking part?

Your contribution, if you choose to participate, will help to generate a more effective web application for cooking recipes targeted for university students.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized. We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team. All electronic data will be stored on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint). Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Justin Howe (s1840358@ed.ac.uk)

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Justin Howe (s1840358@ed.ac.uk)

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

F.3 Questions

Personalized Recipe Food Platform for University Students Evaluation Questionnaire

This study is part of a undergraduate project. For more information, please refer to this link:
Participant Information Sheet: https://uoe-my.sharepoint.com/:w:/g/personal/s1840358_ed_ac_uk/ETzNbW8X7H1EolZVwEuKk7cB6HgUMyWKX-piUpw_J2PUAQ?e=LRwNpy (https://uoe-my.sharepoint.com/:w:/g/personal/s1840358_ed_ac_uk/ETzNbW8X7H1EolZVwEuKk7cB6HgUMyWKX-piUpw_J2PUAQ?e=LRwNpy)

Please answer this 10 minute evaluation questionnaire to the best of your knowledge. You will be asked to evaluate the following website. **As the website prototype is stored in the university servers, you will not be able to access the website if you are not connected to the machines directly on the Informatics network or any Informatics student connected to the Informatics's VPN.** Please refer to the following document for more details: https://computing.help.inf.ed.ac.uk/openvpn (https://computing.help.inf.ed.ac.uk/openvpn)

Your help will be sincerely appreciated. This information would help to generate a more effective web application for cooking recipes targeted for university students.

This study is certified according to the Informatics Research Ethics Process, RT number 2019/11901.

* Required

* This form will record your name, please fill your name.

Consent

1

If you proceed with this survey, you agree with the following statements:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.
- I allow my data to be used in future ethically approved research.
- I agree to take part in this study.

*

◯ Yes

◯ No

General

2

Where do / would you look up recipes online? (Select all that apply) *

- [ ] Epicurious
- [ ] Cookpad
- [ ] Cooking blogs
- [ ] Instagram
- [ ] AllRecipes
- [ ] I never look up recipes online
- [ ] Youtube
- [ ] Tasty
- [ ] Google
- [ ] BBCGoodFood
- [ ] Other

3

If you selected the option 'Other', please elaborate further:

Usability Website Evaluation

Please visit the following student food recipe website -
JustCookStudent: **http://s1840358vm.inf.ed.ac.uk:5000/ (http://s1840358vm.inf.ed.ac.uk:5000/)**

Please make sure you are connected to the Informatics OpenVPN to access the web application due to security reasons.

4

Please indicate how successful you are in completing the following tasks.

The following is the explanation of your possible answers:
Complete Success: You are able to complete the following task without hesitation
Success with Some Difficulty: You are able to complete the following task but the design partially hinders the user from completing the task without hesitation
Complete Failure: You are not able to complete the following task at all
*

	Complete Success	Success with Some Difficulty	Complete Failure
Find the recipe with title name: "Sausage Ragu"	◯	◯	◯
Find recipes with a maximum cooking time of 20 mins	◯	◯	◯
Find recipes with a maximum cooking time of 30 mins and are vegetarian	◯	◯	◯
Find the list of ingredients needed for the veggie pizza recipe	◯	◯	◯
Find the Nutrition Data Per Serving section for the recipe "Paneer-stuffed pancakes"	◯	◯	◯

5

Based on your experience completing those tasks, what did you like best about JustCookStudent? *

6

Based on your experience completing those tasks, what did you like least about JustCookStudent? *

7

Do you have any general suggestions for JustCookStudent?

Design

8

Please rate the website's ease of use *

☆ ☆ ☆ ☆ ☆

9

Please rate the website's navigation *

☆ ☆ ☆ ☆ ☆

10

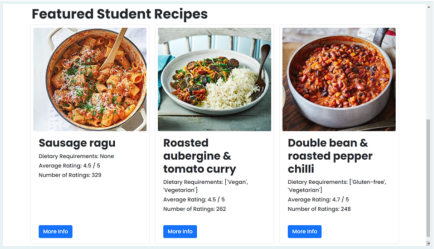
How user friendly is the website's interface? *

☆ ☆ ☆ ☆ ☆

11

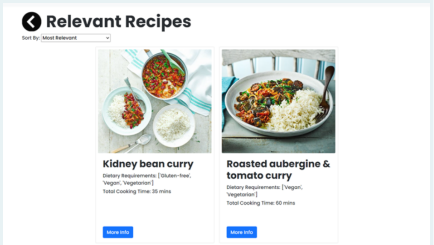
How should featured recipes be chosen?
(Eg: By highest ranking, popularity, or a combination of both or something else?)

Please elaborate further. *



12

What information should the search results include as part of each recipe result? *

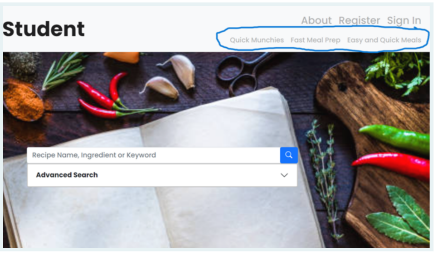


- [ ] Recipe Name
- [ ] Description
- [ ] Total Cooking Time
- [ ] Dietary Requirements
- [ ] Preparation Time
- [ ] Default Number of Servings
- [ ] Average Rating
- [ ] Number of Ratings
- [ ] Nutrition per Serving
- [ ] Cuisine
- [ ] Ingredients
- [ ] Author
- [ ] Equipment
- [ ]

Other

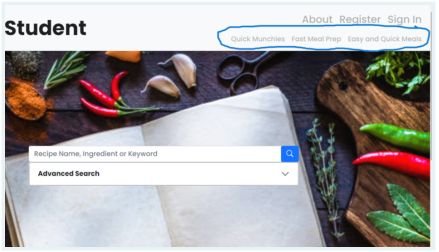
13

How useful do you find having shortcut links as the ones provided? *



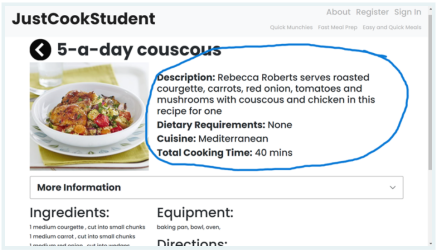
- ◯ Extremely useful
- ◯ Somewhat useful
- ◯ Neutral
- ◯ Somewhat not useful
- ◯ Extremely not useful

14



What do you think about the existing links? Suggest any additional links that you may find useful as a student. *

15



What information should the Recipe Page show as "Essential Information"? *

- [ ] Description
- [ ] Total Cooking Time
- [ ] Dietary Requirements
- [ ] Cuisine
- [ ] Author
- [ ] Nutrition Per Servings
- [ ] Average Rating
- [ ] Number of Ratings
- [ ] Ingredients
- [ ] Equipment
- [ ] Other

16

I still have to add the following features that were recommended by other students. What features should be prioritized? *

- [ ] Filters (for example: lowest price to highest price or highest ranking to lowest ranking)
- [ ] Recipe recommendations
- [ ] Price for each recipe
- [ ] User Login System
- [ ] Ability to change number of servings
- [ ] Sort By functionality
- [ ] Other

17

Do you have any other suggestions for any additional features I should add? If so, describe them. *

18

System Usability Scale (SUS) *

	Strongly Disagree				Strongly Agree
I think that I would like to use this system frequently.	◯	◯	◯	◯	◯
I found the system unnecessarily complex.	◯	◯	◯	◯	◯
I thought the system was easy to use.	◯	◯	◯	◯	◯
I think that I would need the support of a technical person to be able to use this system.	◯	◯	◯	◯	◯
I found the various functions in this system were well integrated	◯	◯	◯	◯	◯
I thought there was too much inconsistency in this system.	◯	◯	◯	◯	◯
I would imagine that most people would learn to use this system very quickly.	◯	◯	◯	◯	◯
I found the system very cumbersome to use.	◯	◯	◯	◯	◯
I felt very confident using the system.	◯	◯	◯	◯	◯
I needed to learn a lot of things before I could get going with this system.	◯	◯	◯	◯	◯

Thank You

19

The website title "JustCookStudent" sounds a bit boring! What title should the website have?
The top 3 votes will be voted in the voluntary workshop (if you choose to participate)
Any inappropriate responses will be removed.

20

Are you willing to participate in a voluntary workshop for the final evaluation of this website? The workshop will consist of a 45 minute session and involves assessing the second iteration of this website.
*

- ◯ Yes
- ◯ No

21

If you answered yes, please provide your email so we can contact you about the workshop: *

F.4 Results

Evaluation Questionnaire Results:

Question 2: Out of the following 23 respondents: 18 said they use Google, 15 use Youtube and 11 use BBCGoodFood.

Question 4: Approximately 75% were able to complete the following tasks with complete success.

Question 5: Students sincerely appreciated the UI design and search for recipes with maximum cooking time. Based on the initial questionnaire from Question 8, the median cooking time most students are willing to cook is between 30-45 minutes.

Question 6: Responses varied significantly. Advanced search could be more intuitive for the user. The results from the search could be improved – preprocessing text?

Question 7: Displaying more relevant information for recipes

Question 11: Popularity seems like the most viable option. However, students would appreciate a combination of popularity and highest rating. (How would the combination work?) S21 - "A combination of both: sometimes one ranking and 5 stars is less informative than 40 rankings with 4.5."

Question 13: 15/23 respondents think shortcut links are at least somewhat useful for the users to find a certain category of recipes quickly

Question 18: Scoring is based on 5-point likert scale from 'Strongly Disagree' to 'Strongly Agree', where a value of 1 is assigned to 'Strongly Disagree' and 5 to 'Strongly Agree'.

Refer to: https://xd.adobe.com/ideas/process/user-testing/sus-system-usability-scale-ux/

Average SUS score among the 23 participants is 78.9. Lowest score is the usage of the system – there are many factors including lack of recipes and possibly little interest. 2 major outliers whose scores are 22.5 and 32.5 respectively.

NOTE: Regarding questions 12 and 15, based from the evaluation questionnaire: I plan to integrate the information which has at least 11 responses.

Appendix G

Updated Set of Requirements

#	Requirement	Priority	Justification
R1	No Ads	Medium-High	Supported by 5/10 respondents from design workshops.
R2	Initial food recipe collection is from BBCGoodFood	High	Supported by 46/87 respondents from the initial questionnaire. Additionally supported by 8/10 participants from design workshops.
R3	Next food recipe collection is from Tasty	Medium-Low	Supported by 10/87 respondents from the initial questionnaire. Assigned with lower priority due to little project implementation duration
R4	Showcases 'Featured Recipes' section	Medium	Supported by 3/10 respondents from design workshops based from their visuals. Less than 1/2 of total participants but creates high impact for usability
R5	Relevant recipes can be sorted by highest rating and number of ratings	Medium	Supported by 4/10 respondents from design workshops.
R6	Advanced Search Engine	Medium-High	Supported by 6/10 respondents from design workshops. This feature is labeled in particular with a high impact that users would want to find recipes based on a recipe name, ingredient or keyword
R7	Search By - Maximum Cooking Time	Medium-High	Supported by 3/10 respondents from design workshops based from their visuals.
R8	Search By - Dietary Requirements	Medium-High	Supported by 2/10 respondents from design workshops based from their visuals.
R9	Search By - Include / Exclude Ingredients	Medium-High	Supported by 3/10 respondents from design workshops based from their visuals.
R10	Search results should be clearly displayed	Medium-High	Supported by 5/10 respondents from design workshops. In addition, high impact is justified with following the 1st heuristic of Nielsen's 10 Usability Heuristics - Visibility of System Status
R11	Title, Author, Website Used	Medium-High	While this was not addressed in the design workshops, it must be ensured prevent copyright infringement.
R12	An image should be displayed for each step of making the recipe	Low	Even though it was supported by 4/10 respondents from design workshops but the high level of technicality required to determine what image should be shown with equipment and ingredients is challenging
R13	Cooking Time Duration	High	76 of 87 respondents in the initial questionnaire agree that they have too little time to cook due to academic commitments. Additionally supported by 7/10 participants from design workshops.

R14	Equipment / Utensils Required for Recipe	Medium-High	Supported by 5/10 respondents from design workshops. While web scraping the recipe data does not indicate equipment used in the recipe, integration of a Food Recipe API will be required.
R15	Nutrition Information for Each Recipe	Medium	Supported by 2/10 respondents from design workshops. In addition, 45% of initial questionnaire participants strongly agreed obtaining a balanced diet is a priority.
R16	Recipe List of Ingredients and Corresponding Price	Medium	Supported by 4/10 respondents from design workshops.
R17	Cuisine type should be displayed	Medium	Supported by 3/10 respondents from design workshops based on visuals.
R18	Recipe Recommendation System	Medium	Supported by 3/10 respondents from design workshops. However, implementing an advanced algorithm that suggests similar recipes will certainly be a challenge.
R19	Ability to change number of servings	Medium-Low	The integration of Spoonacular API will determine the semantic text in order to change number of servings based on ingredients shown
R20	Recipe Page should have functionality to convert measurements for ingredients	Medium-Low	The integration of Spoonacular API will determine the semantic text in order to convert measurements
R21	User Login System where user can save his/her favorite recipes	Low	The high level of technicality required to handle routing, saving user session data into another database. In addition, consideration of confidentiality of user data must be ensured as the web application must be stored on the university servers.
R22	Relevant recipes can be sorted by maximum cooking time	Medium	Supported by 4/10 respondents from design workshops.
R23	Each recipe has total estimated price and price-per-serving	Medium	11/23 respondents supported from evaluation questionnaire; this would require calling Spoonacular API to calculate estimated price for recipe
R24	A image/video(s) which corresponds to each direction step	Low	High technical difficulty in finding certain keywords using advanced text analysis and then putting those keywords as a Youtube search
R25	Substitute ingredients	Low	Implementing an advanced algorithm that suggests similar recipes will certainly be a challenge.
R26	Obtaining recipes from video sources including Tiktok and Youtube	Low	High technical difficulty in using speech-to-text analysis to obtain the directions of the recipes and ingredients

R27	Quick shortcut links	Medium-High	Supported by 15/23 respondents from evaluation questionnaire, where they believe the functionality would be at least somewhat useful
R28	Search By - Maximum Recipe Price	Medium	Supported by 3/10 respondents from design workshops based from their visuals. In addition, 11/23 respondents from evaluation questionnaire believe estimated price for each recipe should be prioritized in the implementation.
R29	Relevant recipes can be sorted by estimated price per serving	Medium-Low	11/23 respondents supported from evaluation questionnaire However functionality for estimated price for each recipe first needs to be implemented first - therefore it has a lower priority

Appendix H

Server Deployment

After I created the first iteration of my web application implementation, I was required to deploy my web application from my local machine onto the university servers in order for the students to evaluate the web application for the first round of evaluation. A computing officer allocated a dedicated server for me to deploy my application. The application could not be accessible outside the Informatics's OpenVPN, due to insecure web application vulnerabilities. In order for the web application to be accessible for university students more widely, and not limited to Informatics students, Neil has approved the application to be opened by opening firewall to a subset of IP addresses which offers permission to university and students using the Informatics OpenVPN.

I have considered other approaches for deployment, as Flask's built-in server is not the most suitable option for production deployment - as one request is allowed at a time. Given the time constraints, I would deploy the food recipe website to production using Heroku to allow university students to access the web application outside the university for summative evaluation.

I faced some initial difficulties when running the web application on the Informatics servers. I ran my script using screen command to let a script run to host the web application running. However, after I logged out and then logged in again the script to allow the web application run. I thought static files were not sent to the server properly and thought I would need to create a server which would handle those static files. However I looked at the console logs more carefully. I realized it was 500 server errors when I attempted to search for recipes. Possibly the screen command did not handle the static files properly without the longjob command. Using https://computing.help.inf.ed.ac.uk/how-do-i-leave-job-running, I used the *"longjob"* command to execute the script. I was then able to conduct the formative evaluation after the first round of implementation.

Appendix I

Project Day

JustCookStudent

Designing and Implementing a Personalized Food Recipe Platform for University Students using Web Data Extraction

Introduction

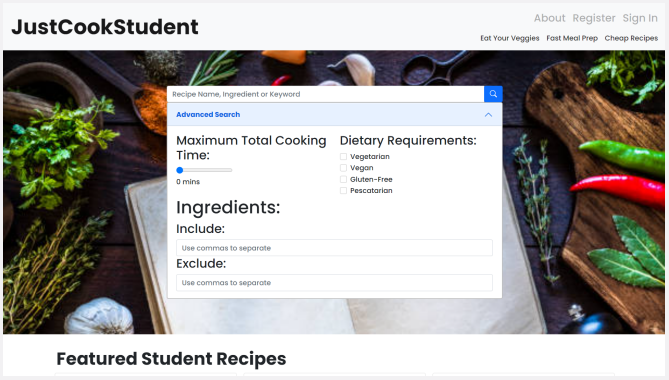
Students juggle with many responsibilities and have little time to cook. I hope to make cooking easier and more interactive. Additionally given a large amount of unstructured data available on the Internet, one can extract food recipes using web scraping to build a food recipe website for university students.

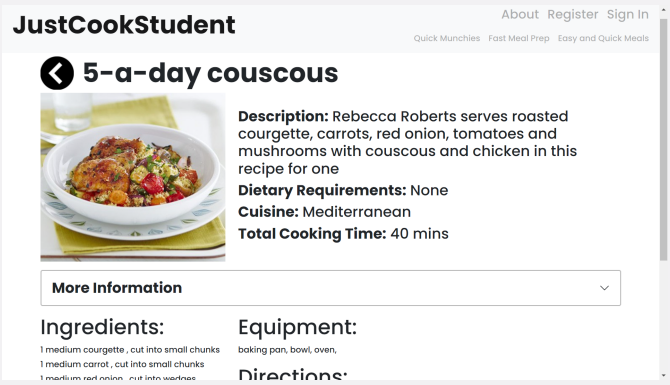
Why JustCookStudent?

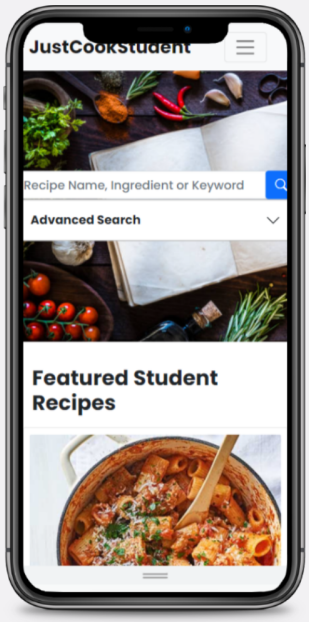
- Recipes are targeted towards **university students**
- Contains features not implemented in other websites
  - **Estimated recipe costs**
  - **Equipment required**
  - **Advanced search**
- **No Ads**

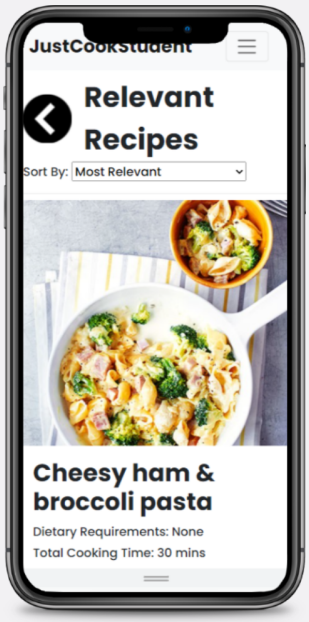
Methodology

- Extensive background research including existing recipe websites
- Gathering requirements - questionnaire and design workshops
- Data Analysis and Design
  - NVivo Qualitative Data Analysis
  - Server Architecture
  - UI/UX Design
- 2 iterations of implementation









Appendix J

Summative Evaluation

J.1 Participant Consent Form

Participant number:_____

Participant Consent Form for Food Recipe Website Evaluation

Project title:	Designing and Implementing a Personalized Food Recipe Platform for University Students using Web Data Extraction
Principal investigator (PI):	Cristina Andriana Alexandru
Researcher:	Justin Howe
PI contact details:	Cristina.Alexandru@ed.ac.uk

By participating in the study, you agree that:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1.	I allow my data to be used in future ethically approved research.	**Yes** ☐	**No** ☐
2.	I agree to take part in this study.	**Yes** ☐	**No** ☐
3.	I agree to be audio recorded in this study.	**Yes** ☐	**No** ☐
4.	I agree to be video recorded in this study.	**Yes** ☐	**No** ☐

Name of person giving consent	Date dd/mm/yy	Signature
_____	_____	_____
Name of person taking consent	Date dd/mm/yy	Signature
_____	_____	_____

THE UNIVERSITY of EDINBURGH informatics

J.2 Participant Information Sheet

Participant Information Sheet for Food Recipe Website – Summative Evaluation

Project title:	Designing and Implementing a Personalized Food Recipe Platform for University Students using Web Data Extraction
Principal investigator:	Cristina Adriana Alexandru
Researcher collecting data:	Justin Howe
Funder (if applicable):	No

This study was certified according to the Informatics Research Ethics Process, RT number 2019/11901. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The main researcher of this study is Justin Howe, who is a final year undergraduate student in the University of Edinburgh School of Informatics. Cristina Adriana Alexandru is his supervisor. This study is conducted as part of an honours undergraduate project.

What is the purpose of the study?

After understanding the students' characteristics and their needs for a food recipe website targeted for university students in an initial study, building a prototype of such a food recipe website and formatively evaluating it with students, this study now aims to involve students in a summative evaluation of a second iteration of this prototype. This will help us understand how usable you find the prototype, what kind of impact it can have on your cooking habits, and gather your suggestions for improving this system.

Why have I been asked to take part?

As a university student with multiple deadlines looming, juggling other responsibilities, such as keeping fit and maintaining friendships during university can be challenging. Therefore, students could be more resistant to cook, let alone spend

time and effort deciding what to cook. Students may be less willing to create weekly meal plans for themselves, and eating out/getting food delivered may be infeasible. Therefore, we want to create a viable solution that would help busy university students to make cooking easier yet interactive using web data extraction techniques.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI who is Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk). We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

This study would be conducted as an online study on Zoom. A Doodle poll will be sent to interested participants, who offered to participate as part of the previous evaluation questionnaire and other students who would be interested to participate. They would then request which timeslots would suit them the most. The timeslot with the most votes would be selected.

This study will take a total duration of approximately 1 hour to complete, and will involve 6-7 students. The study will first begin with a focus group which lasts for 5 minutes, where the facilitator would ask you warm-up questions about your experience with food recipe websites.

During the next part of the session, which would last approximately 40 minutes, the shift of focus would go towards a stakeholder walkthrough. The researcher would define what tasks need to be completed, and provide participants with a link to the prototype. Participants would then be required to complete the tasks on the prototype and share their progress with them. Each participant would be asked to share their feedback for the website implementation, and discuss suggestions with the rest of the group.

Finally, the participants would be asked as part of a focus group to share their views on the potential of the website for impacting student cooking habits (10 minutes). Then, they would be provided with a link to a Microsoft Forms form where they can provide some demographic information and fill in a System Usability Scale questionnaire on the general usability of the prototype (5 minutes).

Are there any risks associated with taking part?

There are no significant risks associated with the participation of this study. Your studies and progression will not be affected. Your feedback and answers will remain strictly confidential and follow the relevant Data Protection Laws. No compensation will be provided for participation in this study.

Are there any benefits associated with taking part?

Your contribution, if you choose to participate, will help to generate a more effective web application for cooking recipes targeted for university students.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized. We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher/research team. All electronic data will be stored on the School of Informatics' secure file servers. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including

rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the Principal Investigator: Cristina Adriana Alexandru (Cristina.Alexandru@ed.ac.uk)

If you wish to make a complaint about the study, please contact

inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be emailed to you by Justin Howe (s1840358@ed.ac.uk)

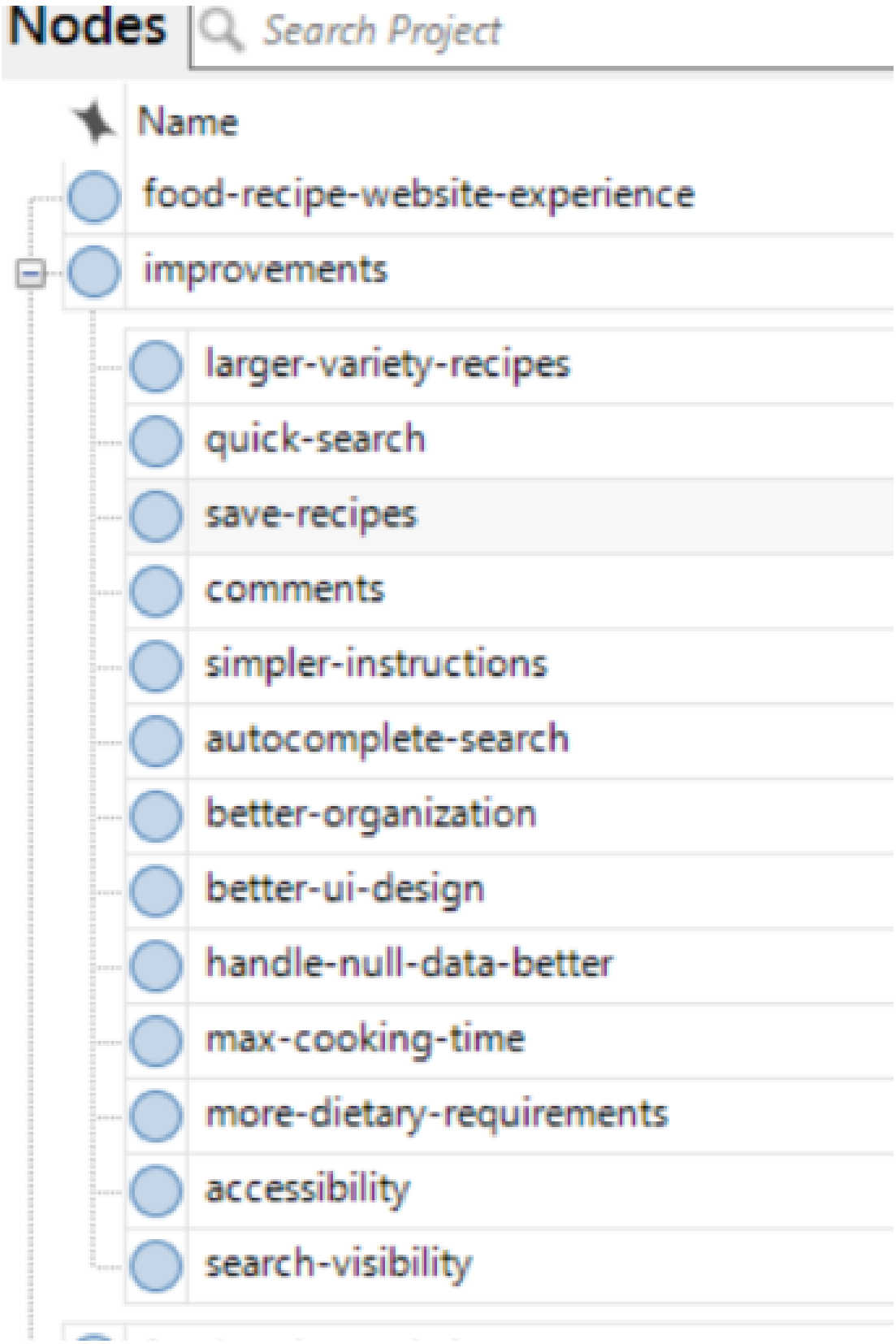
Alternative formats.

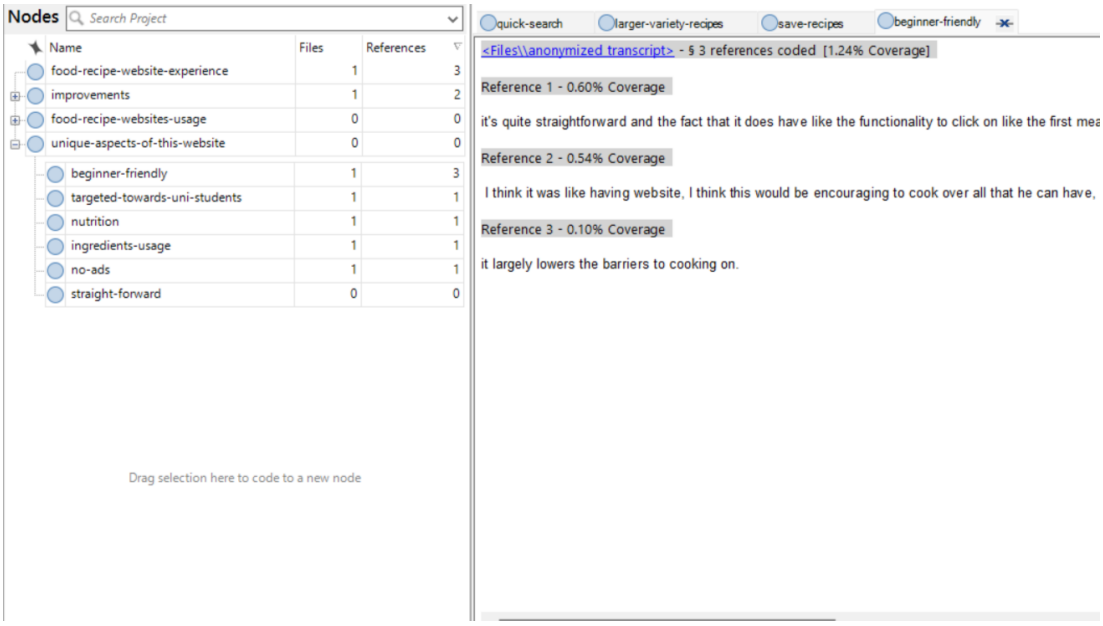
To request this document in an alternative format, such as large print or on coloured paper, please contact Justin Howe (s1840358@ed.ac.uk)

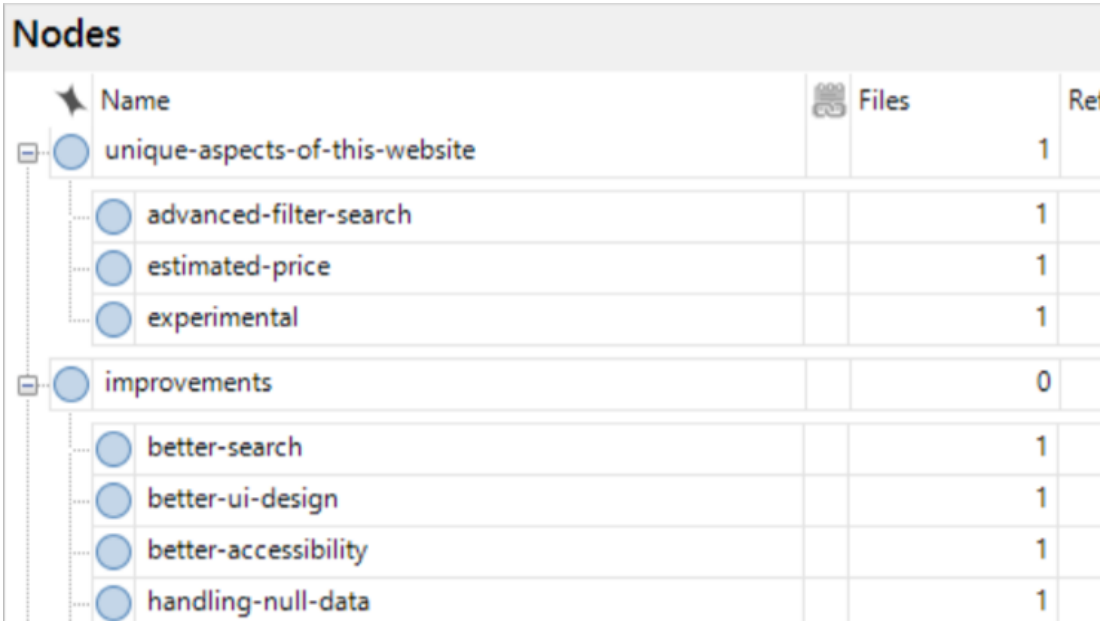
General information.

For general information about how we use your data, go to: edin.ac/privacy-research

J.3 NVivo Data Analysis




Nodes
Search Project
Name
Files
References
food-recipe-website-experience 1 3
improvements 1 2
food-recipe-websites-usage 0 0
unique-aspects-of-this-website 0 0
beginner-friendly 1 3
targeted-towards-uni-students 1 1
nutrition 1 1
ingredients-usage 1 1
no-ads 1 1
straight-forward 0 0
Drag selection here to code to a new node
quick-search
larger-variety-recipes
save-recipes
beginner-friendly
<Files\\anonymized transcript> - § 3 references coded [1.24% Coverage]
Reference 1 - 0.60% Coverage
it's quite straightforward and the fact that it does have like the functionality to click on like the first mea
Reference 2 - 0.54% Coverage
I think it was like having website, I think this would be encouraging to cook over all that he can have,
Reference 3 - 0.10% Coverage
it largely lowers the barriers to cooking on.


Nodes
Name
Files
unique-aspects-of-this-website 1
advanced-filter-search 1
estimated-price 1
experimental 1
improvements 0
better-search 1
better-ui-design 1
better-accessibility 1
handling-null-data 1