

Cooking Companion: A Participatory Design-based Solution for Voice Assisted Cooking

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1 Introduction

1.1 Importance

There is a plethora of food content online, such as aesthetic food pictures on Instagram, food “hacks” on TikTok, or recipe videos on YouTube. As the online presence of the food industry grows, the number of people accessing online recipes also grows. However, following a recipe from a screen can be a hassle. Most smartphone screens are between 4 to 6 inches wide, which forces users to keep their phone at a close distance when reading text on the screen. While this close distance is normally acceptable, it becomes increasingly more apparent as people are navigating around the kitchen, eventually having to return to read their phone screen. Also, if someone is following a recipe through their smartphone, most phone screens automatically lock after a certain period of time. Depending on the recipe, unlocking the screen and scrolling through the recipe can be a messy ordeal. Some users navigate to their phone’s sleep settings and turn off the auto-lock feature for the duration of the cooking session, but this will cause another inconvenience as the phone battery drains more quickly.

These cooking inconveniences become more difficult as the population of potential users expands to include people with visual impairments. Cooking is an instrumental activity of daily living (ADL), essential to increasing an individual’s sense of independence. Blind or visually impaired individuals may experience difficulties while following a read-only recipe on their phone, and a voice-controlled app may be a feasible solution to increase the accessibility of online recipes. Currently, the app Voicipe behaves as a voice assistant that reads the recipe out loud, allowing users to stay hands-free while cooking. The user can ask for the ingredients list, for the previous and next instructions, and for the amounts of the ingredients. Additionally, timers can be set at any point of the cooking process. Another potential solution using voice control involves issuing commands through built in phone voice assistants, although this may vary in success per website, as some websites are coded to be more accessible than others.

Existing voice technology requires specific, rigid commands mapped to specific functions, such as “Hey Siri!” or “Text [person’s name].” Designing a voice-controlled recipe app requires intuitive, short commands that a user can remember while they are following through a new recipe. Being able to detect through natural speech errors, such as “ums” or “uhs” and disregard extraneous information in sentences would be invaluable, placing less effort into the memory of the individual’s speech.

1.2 Approach



Figure 1: The breakfast tortilla wrap recipe page on our website.

We aimed to create a website to help people follow recipes, primarily through the use of voice control. While there are a variety of existing cooking apps and websites, it appears that voice control is not a popular feature within these online settings. Our website allows users to cook and access recipes hands-free, without feeling tethered to the technology’s screen. Furthermore, voice features, i.e., pitch, speed, etc, are customizable to the user’s preferences. Some people may prefer a quicker voice to read out the instructions, while others may require a slower, lower voice to follow along more easily. Hopefully, customization will allow for maximum helpfulness in our website’s voice assistance feature.

Our voice commands include the ingredients list and recipe instructions in the form of checklists, which users can cross off as they gather ingredients and follow the recipe. As there is already existing speech-to-text software online, we used this existing software in our website. Furthermore, the key part in our approach depended on participatory design. With a preliminary study to identify pain points, we then attempted to tackle these solutions in our website’s design. Similarly, an evaluation study was conducted to assess the success of our website and generate ideas for future improvements.

1.3 Implications

Successfully integrating customizable voice control into our app simplifies the cooking process for users. It allows people to focus on the cooking process itself, rather than being forced to visually attend to the recipe on their devices. With the ideals of universal design, our app can increase independence for all types of users. An intuitive interface and short commands make it easy for people to voice their instructions and ask questions as they walk through the recipe, without ever dropping the task at hand!

Beyond cooking tasks, the implications of successful voice control can be expanded to general assembly tasks, as users follow through instructions and supplies to create an end product. Furthermore, interactions between humans and voice technology are very applicable to all devices designed in this age of accessible technology and universal design.

2 Background

As an activity of daily living, cooking is essential to living independently at home or in a community. Cooking also involves the gathering of ingredients, meal planning, clean up, and storage of the food afterwards. Generally, the process of cooking engages multiple layers of higher executive functioning, as multiple items are prepared at the same time. Previous studies have examined the task of cooking breakfast to measure working memory, as people remember the larger goal of the recipe while tackling the smaller sub-goals of each individual step [4]. Other studies have identified that cooking involves multitasking, which encompasses the concepts of retrospective memory, prospective memory, and planning [3]. While cooking, people use their retrospective memory to recall the specifics of recipe details, prospective memory to remember a planned action, and planning to prepare for future instructions.

This multitasking element can make cooking difficult for anyone, especially as there are more items to prepare and information for the mind to remember at once. Unfortunately, in older and disabled populations, we see increased difficulty in cooking independently, as executive functioning declines over time [7]. For the millions of people living with visual impairment worldwide, the process of cooking is complicated even further. Considering many older aged individuals experience some form of cognitive loss and vision impairment (VI), research into cooking and people with VI can reveal insightful information about ways we can design products that support these populations.

People with visual impairments may have trouble shopping for, cooking, and eating meals [2]. Studies have shown that visual impairments can negatively impact people's nutritional status [5], with a higher prevalence of obesity and malnutrition in those populations. These results suggest that there is a great need for interventions and initiatives to support the nutritional status of people with visual impairments through skill building, rehabilitation, etc.

Currently, voice control is becoming a popular feature in assistive technology

developed for visually impaired people [1]. However, there are not many cooking apps with voice assistant technology. Smartphone assistants like Siri and Alexa were not designed specifically to aid in cooking. Smart home assistants like Amazon Echo and Google Home increase the interaction range allowed, but were also not designed just for cooking purposes, so they lack some features. For instance, these voice assistant softwares and screen readers lack the ability to jump from step to step, or repeat previous key information in the recipe. These interactions could be extremely helpful in the cooking process, and developing voice assistants designed specifically for recipe websites can increase the ease of following these recipes.

Presently, Voicipe, Carla, and Alexa can be used as accessible cooking assistants. While users can prompt for recipe instructions and ingredients, there are inconsistencies in accuracy based on the wording of the requests. This is a present challenge of existing voice assistant technologies, and as kitchens are potentially noisy environments, speech recognition should be able to parse through the extraneous words [6]. Furthermore, these voice assistant softwares often require an external device, such as an Alexa for Alexa Skills, which excludes people who cannot afford this technology.

The purpose of our paper is to exemplify the benefits of universal design, making online recipes more accessible in general. We aimed to improve the accessibility features of current voice assistance software, by investigating the key information that users will want to access while following an online recipe. Our approach was informed by participatory design, leading to the voice customization settings and a progress bar to highlight completion of the recipe.

3 Preliminary Case Study

Before designing our website, we conducted a preliminary study to identify the pain points of accessing online recipes and to inform the structure and features we would want to include in our website. In this study, three participants cooked a simple pasta recipe from an online website, accessing it in three different formats and then providing feedback on the experience.

3.1 Participants

Due to time constraints, our convenience sample consisted of 3 participants, who are all sighted with no known disabilities. We recruited people who were nearby or lived in the same house. Since we were interested specifically in the task of perusing the recipe and not the act of cooking, we used sighted participants to reduce the confounding difficulty of the cooking process itself and separate it from the difficulties of reading the recipe while cooking. In one condition, we had a participant use her ears rather than her eyes to access the recipe.

One participant was a third year college student living off campus with her own kitchen and friends. Due to not having a meal plan, she cooks very often, about 10 times a week. She prefers not to follow recipes very precisely, using

rough estimates of amounts, and recipes as inspiration for her cooking. Pasta is one of her favorite foods, so she was excited to try this infamous TikTok Pasta recipe. She accessed the recipe on her phone.

The second participant was a 58 year old mother. She cooks occasionally, 1-2 times a week. She sometimes cooks pasta, and prefers to follow recipes precisely every time. She was not familiar with the recipe we chose for her to cook. Her preferred way to read recipes is on an iPad or printing the recipe out. She accessed the recipe on her iPad.

Our third participant was a first year college student living in a college dorm that has a kitchen. She cooks everyday when at home with her family but never cooks in the dorm, as she is on a meal plan. While she prefers to follow recipes precisely the first time, she uses her intuition to cook familiar dishes. For her condition, one of us pretended to be a voice assistant who read out instructions and responded to her requests (“Could you repeat that?”, “What are the ingredients?”, etc.). She did not access the recipe visually throughout the process.

3.2 Methods



Figure 2: A participant’s baked Tiktok pasta.

For the cooking task, we chose a pasta [recipe](#) from TikTok. We picked this recipe because it prioritized the following:

1. Appropriate complexity of the recipe: The recipe contains multitasking elements while still being relatively simple to cook.
2. Time-based components: The recipe requires the use of a timer to cook the pasta and bake the sauce.

3. Available platforms: The website is accessible through both desktop and mobile devices.
4. Minimization of food waste: Pasta is a widely-liked food and it is unlikely that the food will go to waste.
5. Accommodation of dietary preferences: As a vegetarian recipe, all of our participants will be able to eat the cooked pasta.

The original website included photos and a video that further clarified recipe steps for viewers. However, we felt that the website had a lot of elements, such as paragraph-style instructions in addition to the recipe at the bottom of the page, a video, a long introduction, etc. that we predicted would be a pain point for participants during the study due to their overwhelming nature.

Participants followed the recipe through various access methods. One participant read the recipe on their phone, another participant read the recipe using their iPad, and the third participant had the recipe read aloud to them on request. After finishing the recipe, participants filled out a feedback form. The questions asked about their thoughts on following the recipe, thoughts on the food they cooked, and thoughts on the recipe itself. The purpose of this form was to identify pain points during participants' experience of following an online recipe.

3.3 Results

Statement	A (iPad)	B (Phone)	C (VA)
I felt confident following the recipe. (1 = Not at all; 7 = Extremely)	6	6	5.5
Rate the easiness of recipe (1 = Easy; 7 = Extremely difficult)	2	1	2.5
I was satisfied with the execution of the recipe. (1 = Not at all; 7 = Extremely)	5	6	7
I was satisfied with the recipe. (1 = Not at all; 7 = Extremely)	5	7	7
Did you read the Notes, Tips, and Tricks section? If yes, how useful were they?	N/A	N/A	N/A
How easy was it to locate the recipe on the website? (1 = Easy; 7 = Difficult)	5	6	N/A

Table 1: Summary of key questions from preliminary study questionnaire

Overall, participants felt confident following the recipe and found the TikTok pasta to be a fairly easy recipe. They were all satisfied with the recipe as well as their execution of it. All participants enjoyed making the recipe and would make it again. The first two participants, who accessed the recipe visually on their phone and iPad respectively, found it difficult to locate the recipe on the website; they had to scroll to the bottom of the webpage and were confused by

the presence of the same recipe in paragraph form within the blog post. None of the participants read the “Notes, Tips, and Tricks” section and mentioned not realizing that the section existed. Difficulties participants encountered had to do with timing, determining readiness of the meal at various stages, and exact quantities of ingredients.

3.4 Discussion

Overall, the difficulties with following the recipe concerned either the nature of the recipe instructions or the online format of the recipe itself. In order to address the problems of the recipe instructions, we plan on pre-processing and editing the website to break down ambiguous steps and ingredient quantities.

3.4.1 Visual Layout

In order to address the problems of website layout, we decided to limit the amount of information on the screen at any moment in time. Ingredients and instructions were presented in the form of a checklist, so that users can check off the ingredients as they use them, to provide a mental image as they progress through the recipe. Lastly, we included a progress bar on screen to help users visually gauge their progression through the recipe. The progress bar is designed to fill up as the user checks off steps under the Directions section.

3.4.2 Auditory Feedback

In the third condition of our preliminary study, our participant accessed the recipe through a friend who pretended to be a voice assistant; therefore, the participant used only her ears, and not her hands and eyes, to access the recipe. The participant used commands like “How much of X ingredient do I need?”, “Could you repeat that step?”, “What’s the next step, please?”, etc. while cooking. Based on these observations, we decided to include voice commands with similar purposes in our voice assistance feature. While following a recipe on our website, the user can issue the following commands and more:

1. Read ingredients: Lists out all the ingredients.
2. Read [specific ingredient]: Reads the required quantity of the specified ingredient.
3. Step [number]: Reads out the requested step.
4. Next step: Reads the step that follows the one that was most recently requested.
5. Repeat: Repeats the step that was most recently requested.

The participant also mentioned that it was helpful to not have to stop a task to look at the recipe, as she could simply use her voice and ears for further instructions. She also did not have to constantly wash her hands between steps to scroll through the directions, as she had a “voice assistant” instead.

3.4.3 Recipe organization

Based on the feedback we received about the recipe itself, we decided to restructure the formatting of the recipes on our website. The original website used in the preliminary study had a “Notes, Tips and Tricks” section at the end of the recipe. However, none of our participants used this section, and the participant in the third condition (friend helper) did not know the section existed, because it only appeared at the end of the recipe. For this reason, we got rid of the Tips and Tricks section and instead incorporated relevant ones into the recipe directions. We also reduced the length of each step and broke down complicated steps into multiple steps to reduce cognitive load. We also re-ordered the ingredients section and split it up into subsections like “Pasta”, “Sauce”, and “Garnishings.”

4 Implementation: Cooking Companion

Using the results from our preliminary study, we created a website with both visual and auditory feedback to address the difficulties experienced while following an online recipe. The main focus of our website’s functionality lies in the available voice assistance that users can interact with while following a recipe.

4.1 Informed design

We implemented our accessibility features within the visual format and voice assistance features, informed by our observations and feedback from the preliminary study. In general, we aimed to lighten the cognitive load for the user, by limiting the information on the screen, shortening the recipe into succinct bullets of ingredients and instructions, and providing visual cues that indicate the user’s progress through the recipe. Furthermore, our available voice assistance commands were heavily informed by the pretend voice assistant condition of our preliminary study.

4.2 Website pages

Our [website](#) prototype includes 3 main pages: the home page, the recipe page, and the submit page. Across all of these pages is a consistent dark navigation bar at the top of the page, with visual feedback as the person hovers their cursor over the hyperlink buttons.

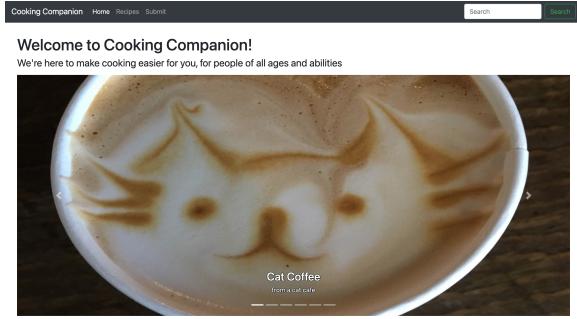


Figure 3: The home page

The home page is where users first interact with our website. There is an image carousel of aesthetically pleasing dishes, and users must click the arrows on the left and right sides of the image. We did not implement a time-based rotation through the images, allowing the user to determine when they want to click to the next image. There are multiple different ways that users can click through the carousel, either through mouse click or keyboard press.

Additionally, there is alternative text provided underneath each image, enhanced with a slight shadow behind the white text. This alternative text extends to the backend code, with a description in the “alt-text” tags, allowing for screen readers to read off these descriptions.

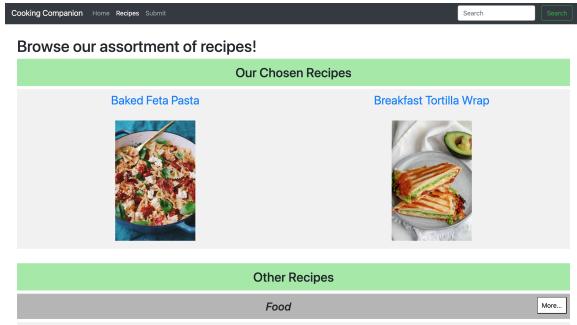


Figure 4: The recipe page

Our recipes page features the two main recipes that we used in our preliminary and evaluation case studies. There is also a skeletal implementation of where future recipes can be featured, under distinct categories of Food, Drinks, and Desserts. These headings are clearly contrasted with the rest of the website with light green and grey backgrounds.

For each recipe, we included a hyperlink to the respective page and an image of the food itself. Users can either click on the recipe name or the image, and both will redirect the user to the recipe page. This increases the size of the

clickable screen space, increasing the ease of navigation through the website. Similar to our home page, alternative text is provided within the “alt-text” tags of the code.

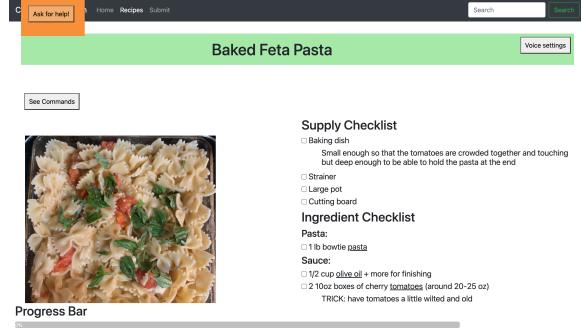


Figure 5: The pasta page

This page displays a modified version of the TikTok pasta recipe used in the preliminary study. This page includes the voice control feature, as well as other accessibility features such as ingredient and recipe step checklists and a progress bar. Users are able to cross off completed recipe steps, which advances the progress bar to visually indicate their progress through the recipe. These features are duplicated on our second recipe page for the breakfast tortilla wrap.

Figure 6: The submit page

The submit page is where users can fill out a feedback form, providing potential new recipes or any other suggested features for our website. Each text box includes a suggested format of the input responses to clarify the questions to the user. Underneath the form, we have included some resources related to our project, such as Voicipe, Carla, a list of speech to text software, as well as our source code for this project.

4.3 Voice control feature

To implement the voice control feature, we chose to use the Web Speech API. While this software can only be used on Google Chrome Desktop and Google Chrome Android, there is extensive documentation online about this software. This makes it ideal for our project's time constraints and limited background knowledge of JavaScript. Additionally, this voice API is able to convert text to speech and speech to text, which matches up with the desired functionality of our website.

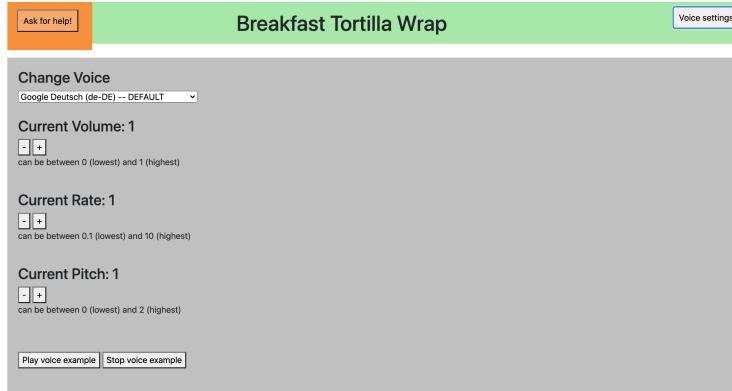


Figure 7: The voice settings on our website.

The voice functionality is implemented on our pasta page and our breakfast tortilla page, and will assist users as they are following the recipes. There is a button that the user can click on to show/hide the settings to change the voice features. These settings include changing the voice, the volume, the rate of the voice, and the pitch of the voice. On changing a setting, the website displays the new value, and the user can play a sample message to check their satisfaction with their new settings.

Users can click on the “Ask for help” button, which triggers the voice assistant to listen for voice commands. Specific commands that are coded into our website are listed on the webpage for the user’s convenience in a collapsible section controlled by a toggle button. The webpage indicates when the assistant is still listening and when it has stopped listening. At the end of each voice command, the webpage displays its interpretation of the auditory input and its confidence level in the accuracy. The voice assistant provides feedback when it does not pick up a recognized request.

4.4 Other features

While the main focus of our study is to provide voice assistance to people who are cooking, our website also contains features that reduce the cognitive load of the user. The list of ingredients and directions on our website doubles as

a checklist, so users do not have to recall from memory which ingredients and steps they have already taken care of.

Supply Checklist
<input checked="" type="checkbox"/> Pen
<input type="checkbox"/> Spatula
<input type="checkbox"/> Knife
Ingredient Checklist
<input checked="" type="checkbox"/> Large burrito-sized <u>tortilla</u>
<input type="checkbox"/> 1 tablespoon <u>butter</u> + more for greasing pan
<input type="checkbox"/> 2 eggs + scrambled egg ingredients
<input type="checkbox"/> 1/2 <u>avocado</u> mashed
<input type="checkbox"/> 2 tablespoons chunky <u>salsa</u>
<input type="checkbox"/> 3 tablespoons shredded mozzarella <u>cheese</u>

Figure 8: Checking off supplies and ingredients.

As users cross items off the step checklist, the instruction turns grey and the progress bar on the bottom of the screen advances, providing further visual cues that indicate their progress through the recipe. We chose to make the progress bar sticky, so the user can continue to view their progress even as they scroll through the webpage.

Directions (Checklist)

1. Place the tortilla on a flat surface. Use a knife to make a cut from the bottom edge of the tortilla to the center along the radius.
2. Heat the butter in a pan and scramble two eggs the way you like them.
3. Imagine the tortilla made up of four quarters. We are going to fill each of these quarters with a different filling.
4. Place each of the four fillings, i.e., the 2 scrambled eggs, 3 tablespoons of shredded cheese, 2 tablespoons of salsa, and 1/2 mashed avocado, into their own quarter on the tortilla. Be careful not to overfill them!
5. Starting with the bottom right quarter, fold the tortilla over the top right quarter, then over the top left quarter and finally, over the bottom left quarter to form a triangle shape.
6. Transfer the tortilla to the same pan with a little extra butter for greasing.
7. Cook it until golden brown and crispy, about 2-3 minutes. Flip and cook until the cheese is melty.
8. Remove from heat and allow to rest for one minute and serve.

Progress Bar



Figure 9: Step 1 and 2 have been completed, and the progress bar has been updated.

4.5 Demo Video

We also filmed a [video](#) featuring key functionality of our website's voice assistance.

5 Evaluation Case Study

After developing a prototype of the website, we performed a follow-up study with the same participants from the preliminary study to assess the website's functionality and get feedback to inform further modifications. We chose a different recipe, a [breakfast tortilla wrap](#), due to the participants' familiarity with the first recipe and ensured that the new recipe was of similar difficulty to the first one. Participants then filled out a questionnaire that hoped to directly compare their experiences from the preliminary study with their experience of using our website.

Before conducting the evaluation study, we made modifications to the breakfast tortilla wrap recipe from its original website to simplify its directions. In doing so, we aimed to reduce the cognitive load of following the recipe, making it further accessible. We wanted to focus on the pros and cons of our website's features as opposed to those of the recipe.



Figure 10: A participant's cooked tortilla wrap.

6 Results

Statement	A (iPad)	B (Phone)	C (VA)
I felt confident following the recipe. (1 = Not at all; 7 = Extremely)	7	7	6
Rate the easiness of recipe (1 = Easy; 7 = Extremely difficult)	1	1	2
Did you use the checklist feature?	No	No	No
Did you use the progress bar feature?	No	No	No
Was our website navigable?	Yes	Yes	Yes
Would you use our website again?	Yes	Yes	Yes

Table 2: Summary of key questions from our feedback form.

Overall, the participants felt confident following the breakfast tortilla recipe and found the recipe very easy. In comparison to the preliminary study, participants were slightly more confident and found the recipe slightly easier when using our website. In response to our website's design, all participants thought our website was easy to navigate. However, one participant chose not to use the voice feature at all, although she appreciated having the option. On the other hand, Participant C relied entirely on the voice control feature and did not view the text format of the recipe throughout her cooking process. Participant B noted that outside of this case study, she probably would not use the voice assistance feature, preferring to skim through the recipe quickly at the cost of precision. Aside from the voice feature, not all accessibility features were obvious to our participants. For instance, none of our participants realized that the "Directions" section doubled as a checklist that advanced the progress bar, so they did not use either feature while cooking.

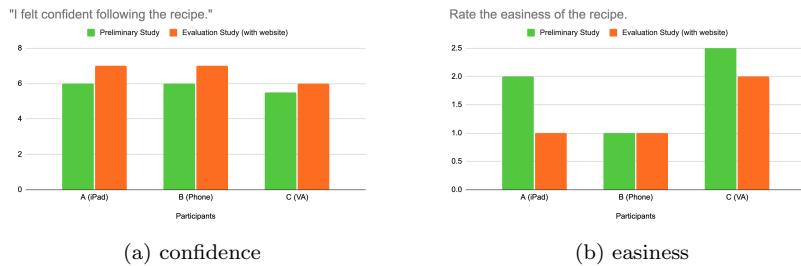


Figure 11: Confidence scale is 1 = Not at all, 7 = Extremely. Easiness scale is 1 = Easy, 7 = Extremely difficult.

7 Discussion

Overall, participants enjoyed the help that the voice assistance provided, enabling users to access the recipe instructions with their voice. Through the feedback form, participants provided useful critiques and suggestions that we integrated into our revised implementation of the website. The changes are as follows:

1. “Ask for help” button: This button is now sticky and draggable, following the user’s location as they scroll through the page. As this button is key to activating the voice assistance, participants noted that the fixed location of this button on the top of the page was a minor inconvenience to accessing the voice assistance feature. We also changed the color of the button to contrast with the background color of the webpage.

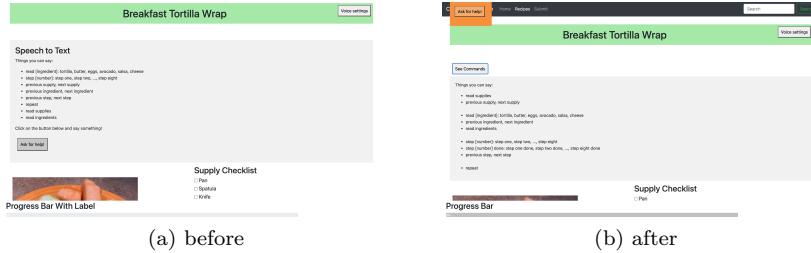


Figure 12: Modification to voice command instructions

2. Collapsed voice command instructions: The voice command instructions are now collapsible, to reduce the amount of screen space that this text occupies.
3. Checklist features: We visually indicated the checklist feature within the instructions by revising our directions header to “Directions (Checklist),” since users were not aware of this feature without this indicator. Also, users can now click the entire instruction to cross it off, rather than a tiny checkbox.
4. Simplified and shortened recipe steps: We condensed some of the instructions within the original breakfast tortilla recipe, to make it easier for users to conceptualize as they’re listening to the recipe instructions.
5. Platform accessibility: We added a note to the bottom of the page with our website’s supported platforms.

As it stands, our website cannot be used fully hands-free, as the voice assistance feature is only present within the recipe webpages. Based on feedback from our follow-up study, additional voice commands to check off items and steps, set timers, etc. would contribute to a hands-free experience. Furthermore, changes

in voice settings are not saved across all webpages and are reverted to the default settings upon refreshing. Finally, our current voice assistance software does not meet the level of sophistication as that found in popular voice assistants like Alexa, which means that the recognized voice commands sound robotic, like “Step One”, rather than natural speech, like “Could you read the first step, please?” or “What’s the first step?”. Further improvements in the accessibility of our website would incorporate these features; however, they are beyond the scope of this project.

7.1 Contributions and Implications

The feedback and observations received from our case studies helped us develop the following guidelines.

1. As with any website, following the [Web Content Accessibility Guidelines](#) increases the accessibility of online recipe websites.
2. Voice navigation
 - (a) Voice commands: The recognized voice commands should correspond to actual tasks that one would perform while perusing a recipe. For example, on reading a step that directs the user to mix multiple ingredients, the user would likely refer to the ingredients section to check for quantities. Therefore, the voice assistant should be able to support such modular requests. The commands should be intuitive and succinct.
 - (b) Voice settings for customizability: Users should be able to change attributes of the voice assistant, such as pitch, speed, volume, etc. to their preferred settings for greater accessibility.
 - (c) Ideally, the voice assistance software should enable the user to navigate the website entirely through their voice and auditory feedback, similar to popular voice assistants like Alexa and Siri.
3. Reducing cognitive load
 - (a) Simplified directions: Online recipes should provide concise, easy to remember steps. Ingredients should be organized into chunks for clarity; for example, “Crust” and “Filling” in an apple pie recipe. Another strategy could be to include quantities of ingredients within the instructions, so that the user does not have to pan back to the ingredients section.
 - (b) Checklist: A checklist format is easy to parse and allows users to easily keep track of their current step without having to recall their progress from memory.
 - (c) Clear indicators of recipe location: Online recipe websites often begin with long irrelevant introductions peppered with stories and ads that

are frustrating to skip through when using screen readers. While getting rid of these sections is an ideal solution to reducing visual and textual noise on the website, sometimes, these introductions are necessary for copyright, blogging content, or monetary purposes. In those cases, including an anchor link or a jump link that allows users to skip straight to the recipe can greatly increase the accessibility of the website.

- (d) Additional material: The recipes should be supplemented with optional videos and pictures to clarify instructions. Features like progress bars provide non-text visual cues that encourage the user to complete the recipe.
- 4. Accessibility information: Through our follow-up study, we realized that not only should websites include accessibility features, but it is also important to indicate that the features are available so that users can take advantage of them. Our study participants were not able to benefit from our checklist and progress bar features, as they did not know the option existed. Websites should include a webpage dedicated to informing users about the accessibility features.
- 5. Feedback form: Include some way for users to submit feedback on the website's accessibility and content, as user feedback informs where the website might be falling short and needs improvements.

While screen-readers and similar text-to-speech assistive technologies make websites more accessible to people with visual impairments, they do not relieve many of the frustrations that come specifically with following online recipes. For example, a screen-reader cannot respond satisfactorily to a common request like "How much flour do I need?", but this issue can be resolved by integrating a voice assistant developed specifically for cooking purposes into the online recipe. With further testing of accessible online recipe websites, the generated guidelines above can be refined, polished, and implemented in more cooking websites. With advances in technology and accessibility, people with visual impairments can now overcome the barrier of cookbooks through online recipes, and it is essential to make such online resources accessible to these populations.

7.2 Limitations and Future Work

Both our preliminary and evaluation case study tested 3 participants, which is a limited sample size. While participant ages ranged from 18 to 58 years of age, none of the participants had any known disabilities. Our website implementation may be based on participatory design, but a more diverse sample including participants with visual impairments may greatly inform further accessibility features to implement in our website. Additionally, including more participants in future studies will increase the overall quality of our website, in terms of accessibility and intuitiveness.

Our final website solution exists as a prototype, with various limitations in implementation features. For the purposes of the two case studies, we included two recipes to test the participants, but a fully implemented website should have a variety of other recipes for users to browse through and allow for users to upload their own recipes. Ideally, our current code could serve as a template for other recipes, increasing the ease of scalability of our recipe website.

There are also limitations with our website's voice assistance feature. The voice assistance currently only works on Google Chrome Desktop and Google Chrome Android; therefore our website is inaccessible to those who do not use Google Chrome or have other mobile devices. Also, the voice dropdown menu within the settings does not always consistently load, which may be frustrating for users.

Both of these issues are potentially due to the voice API software that we decided to use, and future improvements to our website may require the use of a different voice API, with increased compatibility with devices like the iPhone and iPad. Also, our current website is not navigable completely though voice commands, nor are the voice settings saved as users click to a new page.

Future research into voice assisted cooking websites should expand beyond the limitations of our prototype, including navigability across all pages and saved voice settings. This customizability and consistency across all pages will allow for a completely hands free experience, as users listen to recipes and follow through the instructions. As voice assistance technology advances, being able to recognize more natural-sounding language will decrease the learning curve of using voice technology, making it easier for everyone to use.

8 Conclusion

Following recipes from online recipe websites is often frustrating as it requires users to stop their task, clean their hands, and look away from the kitchen counter to visually access the directions. Furthermore, the inaccessibility of these websites makes it nearly impossible for disabled cooks to use them. Some ways to combat these problems is to include features such as voice assistance, checklists, simplified steps, progress bars, etc. Our preliminary study confirmed that allowing a cook to access a recipe using their ears and voice commands increases the convenience of following the recipe. The website we then designed focused on the voice assistance feature while also incorporating other accessibility features. In the follow-up study, participants showed a preference for the voice assisted cooking experience, supporting our hypothesis that this feature facilitates the process of following online recipes. Future work in this area should involve participatory design with a diverse population and more sophisticated voice API software.

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