LIMITING RISK THROUGH DESIGN: THE EFFECTS OF USER EXPERIENCE AND USER INTERFACE DESIGN ON FOOD ALLERGEN SAFETY TRAINING

by

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DEDICATION

This thesis is dedicated to my husband, Gordon, and my children, Elijah, Hannah, and Abigail, for their unwavering support and understanding, and the many personal sacrifices we made during my graduate education; my parents, Charles and Sharon, for their love and support; my sister, Tiffany, for always believing in me; and all the friends and family who have helped me along the way.

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ABSTRACT

With the recent rise in gluten intolerance and celiac disease, food allergen safety training in restaurants is becoming necessary in order to create safer eating environments for those with gluten sensitivities. Traditional restaurant employee training often does not provide sufficient information for the prevention of cross-contamination in commercial kitchens. In addition, the training material itself is not designed for how people learn and process information, resulting in poor retention and comprehension of the training material.

This research describes the creation of a restaurant employee training system, based on cognitive psychology, designed to engage the users through interactive gaming and storytelling elements, and to improve the users' recall of the information. The traditional pages of written material typical of employee training manuals are replaced with an online interactive learning experience through the use of simplified content, iconography, gaming, and storytelling. Designing the learning experience with the psychology of how people learn in mind, and including fun interactions and challenging games creates a visceral experience that resonates with the users.

User testing of a small sample revealed that the user experience and user interface design had positive effects on the users' ability to recall the training material, with all of the participants favoring the integration of the gaming and storytelling elements.

CHAPTER I

Introduction

Food allergies and their consequences are seldom considered by those not personally affected, though it is estimated over 150 million people worldwide suffer from some form of food allergy ("Food Allergies," 2011). Diagnosis of sensitivity to wheat and gluten has seen a dramatic increase over the past 10 years, to the point that, what was once 1 in 2,500 affected Americans is now 1 in 133. For those with celiac disease, "an autoimmune digestive disease that damages the villi of the small intestine and interferes with absorption of nutrients from food," and for those with milder cases of gluten intolerance, following a life-long, strict gluten-free lifestyle is the only course of treatment (National Foundation for Celiac Awareness, 2011). In the earliest sections of this research, the information is not intended to dispute the ongoing debate about gluten intolerance and genetic predisposition to celiac disease, but is presented merely to provide insight on the history of man's eating habits and how wheat was a mismatch from the start.

Why the Rise? Why Now?

The recent increase in gluten allergies is attributed to a number of factors. To truly understand the implications that gluten grains have on our health, the history of human eating habits and the evolutionary history of gluten grains need to be considered. Humans are hunter-gatherers by nature, and as such thrived on eating meat, fish, organs, vegetables and fruit for millions of years. Grain did not become a part of our diet until the past 12,000 years. According to Dr. James Braly and celiac disease researcher, Ron

Hoggan (2002) in *Dangerous Grains: Why Gluten Cereal Grains May Be Hazardous to Your Health*:

> Our immune sensitivities and our nutritional requirements are decreed by the millions of years during which nature shaped our genes, our biochemistry, and our bodies. It did so through the interaction between the food in our environment and our ability to use it for energy, growth, and health. Thus available foods shaped our genes, and our genes shaped our dietary requirements. (p. 21)

Grains lacked the nutrients our systems required, and contained substances harmful to our bodies as well. Faced with extinction and reduced population of the world's large mammals, humans had to adapt to this new agricultural lifestyle in spite of our inability to digest some parts of the grains. These undigested partial proteins, or peptides, enter the bloodstream and trigger exorphins, which have morphine-like properties and simulate feelings of happiness and satisfaction, thus becoming addictive in nature. The phrase "comfort food" originates from our bodies' reactions to gluten grains (p. 23).

The first strain of wheat, einkorn, was harvested during the Pleistocene era, around 8500 BC, by the Natufian nomads roaming the Fertile Crescent in the Middle East. They harvested the wheat from the area's indigenous plants and then ground it by hand into porridge. It eventually reduced their need for hunting and gathering and became an essential part of their diet. This signaled a shift from harvesting wild grain to cultivating it, which in turn shaped the Natufians' migratory patterns and led to the development of tools, language, and culture. "It marked the beginning of agriculture, a lifestyle that required long-term commitment to more or less permanent settlement, a

turning point in the course of human civilization" (Davis, 2011, p. 15–16). Agricultural practice became more prevalent across the globe as it offered an alternative for long-term food storage, helped forage communities, and defense against famine. In 1991, archaeological excavation of a mummified Late Neolithic hunter in the Italian Alps revealed partially digested remains of einkorn wheat still existed in the hunter's intestines over 5,000 years after the his death (Rollo, Ubaldi, Ermini, & Marota, 2002).

Shortly after the cultivation of einkorn began, it crossbred naturally with goatgrass—another grain—to produce a new variety of wheat called emmer. The addition of the genetic code of goatgrass made the chromosomes of emmer more complex than einkorn. The parent 14-chromosome einkorn and the child 28-chromosome emmer continued to be harvested and cultivated for the next several thousand years. Emmer wheat flourished in ancient Egypt and it is there that it was discovered that the addition of yeast would make the wheat rise (Davis, 2011).

At some point in the millennia, emmer wheat mated naturally with *triticum tauschii*, a wild goatgrass, yielding genetically modified 42-chromosome wheat known as *triticum aestivum*. For the following centuries, triticum wheat changed little but traversed the globe immensely. It made its way to the New World when Christopher Columbus first planted the grains in Puerto Rico in 1493. The seeds were spread to the American southwest when Spanish explorers accidentally brought wheat seeds in a sack of rice to Mexico in 1530. In 1602, the grains made their way to New England by Bartholomew Gosnold, the discoverer of Martha's Vineyard. The expansion continued as the Pilgrims transported wheat on the *Mayflower*. The triticum wheat species remained untampered with, even through the mechanization processes of the Industrial Revolution, until the late

20th century, when hybridization transformed the grain (Davis, 2011). Demands for greater yields, decreased production costs, and faster growth rates stemmed a need for the government and scientists to further genetically modify the triticum strain. In a righteous effort to solve world hunger, and in perhaps a more conceited effort to stimulate the economy, genetic scientists began crossbreeding hundreds of strains of wheat and grasses, making their chromosomal make-up more and more complex. Most of these strains were generated at the International Maize and Wheat Improvement Center (IMWIC) in Mexico. It began as an agricultural research program in 1943, funded by the Rockefeller Foundation and the Mexican government, but it quickly grew into a global effort and produced thousands of new strains of wheat by the 1980s. One such strain, and the most popular wheat in modern agriculture today, "dwarf" wheat, was created at IMWIC by Dr. Norman Borlaug, for which he won the Nobel Peace Prize in 1970. Dwarf wheat, named for its genetically engineered shorter stalk, has extremely high yield potential and is therefore the wheat of choice in agribusiness. "The average yield on a modern North American farm is more than tenfold greater than farms of a century ago" (Davis, p.14). Wheat today has been so far removed from the wheat of our ancestors, that modern crops are "unable to survive in the wild without human support such as nitrate fertilization and pest control" (p. 22). All of this new advancement was stimulating for the economy and for helping to solve world hunger, however little attention was paid to the implications these genetically modified wheat strains have on human health.

Wheat gluten proteins undergo considerable structural change during hybridization. In order for these new grains to withstand more hostile environments and growing conditions, and to germinate within a shorter time span, they have to contain

higher levels of gluten storage proteins. Gliadin, one group of these storage proteins, has shown to be the most damaging to the human intestines in cases of gluten sensitivity and celiac disease. The other group of these storage proteins, glutenins, is associated with increased risk of autoimmune disease and asthma. According to Braly and Hoggan (2002), "Digestion of these storage proteins requires very specific digestive enzymes, which most of us lack" (p. 26). Ironically, the very same characteristics that harm us also make these grains more attractive for culinary use, as the high gluten content makes them more heat resistant, increases the elasticity and malleability, and provides a more desirable, lighter texture. The fact that we are not genetically predisposed to consume wheat is exacerbated by the thousands of genetic mutations created by scientists in an effort to produce more agricultural yields, with little regard to human safety and long-term adverse effects.

Celiac and gluten sensitivity are genetic conditions. In fact, there is biological evidence that these conditions are inherent from our ancestors and where they settled. Analysis of human leukocyte antigens (HLA), molecules found on the surface of most cells in the body, can indicate how long people of a certain population have been growing and ingesting gluten grains. For example, the genetic marker HLA-B8, which is found in approximately 80% of celiac patients, has been identified in less than 10% of people living in the area where wheat was first cultivated thousands of years ago in Europe. However, it is found in more than 30% of the population living in the far northwest of Europe, where modified wheat cultivation was introduced at a much later date due to unfavorable growing conditions. Populations exposed to higher instances of gluten grains within the last century show the most negative impact. Aboriginal communities recently

introduced to gluten-rich diets are showing increased suffering from diabetes, thyroid disease, cancer, iron deficiency, malnutrition, depression, and celiac disease (Braly & Hoggan, 2002).

In the United States, diets are commonly restricted to small selections of meat, if any, a narrow selection of fruits and vegetables from hundreds of species of edible plants, and the rest of the diet consists of mostly wheat and dairy. "Dairy and gluten-grain products combine to make up the top six foods we now eat. Yet cow's milk and wheat are two of the most commonly reported allergens in the world" (Braly & Hoggan, 2002, p. 35).

Defining Gluten Intolerance

Until recently, gluten intolerance has not been a widely accepted diagnosis. Delayed acceptance of new information about the effects of gluten on non-celiac gluten sensitive people has caused a rift in the medical world, between medical professionals who still follow old definitions of what constitutes celiac disease and forward-thinking doctors and scientists who believe that there are different levels of intolerance for everyone.

The first cases of diagnosed celiac disease occurred in 1888, when Dr. Samuel Gee identified a patient's failure to thrive due to digestive distress, and malabsorption. Dr. Gee prescribed the patient eat a mussel-only diet, which improved the patient's health but still left questions unanswered abut why the patient was sick in the first place. The disease was coined as Gee-Herter's syndrome, after the research conducted by Gee and Christian Archibald Herter, the author of a book about "intestinal infantilism," retarded growth in children with malnutrition, surfaced in 1908 (Davis, 2011; Herter Lecture

Series, n.d.). Gee-Herter's syndrome was later renamed celiac disease after a translation of a circa AD 100 Greek text by Aretaeus of Cappadocia. In the manuscript, "The Coeliac Affection," named after the Greek word "koelia" meaning "abdomen," Aretaeus described the intestinal affliction suffered by his people and their need to fast in order to purge the sickness (Guandalini, 2007).

The connection between wheat and this progressive disease was not established until 1936, when Dr. Willem-Karel Dicke observed a mother of a celiac child describe immediate improvement of the child's rash when she did not feed him bread. Dicke witnessed widespread improvements in the population suffering from the disease when subsequent food shortages during World War II made bread scarce (Adams, 2010; Van Berge-Henegouwen, 1993). However, Dicke's discovery that a wheat-free diet resulted in a full remission of symptoms did not gain acceptance until the 1950's, when the invention of a surgical device to biopsy tissue samples from the lining of the small intestine further proved this hypothesis and redefined the disease (Braly & Hoggan, 2002). This new definition of celiac disease, though a step in the right direction, still only applied to certain cases where intestinal damage was required to be verified by a biopsy. The trouble with this rationale is that there are many forms of celiac and gluten sensitivity, some of which have atypical symptoms, some present itself without symptoms, and even some cases where intestinal damage only shows up years later.

Non-celiac gluten sensitivity, or gluten intolerance, is yet another way that allergies to wheat present itself. In this form, which is the most common of all forms today, the sufferer doesn't present with intestinal damage, but has antibodies circulating in the blood that cause damage to other vital organs, tissues, and systems of the body.

World-renowned gastroenterologist and celiac disease researcher, Dr. Michael Marsh, has petitioned that celiac disease be renamed "gluten sensitivity," creating a broader definition to include anyone showing adverse reactions to gluten. Research shows that gluten sensitivity "may affect as many as 90 million Americans" and living a gluten-free lifestyle is the only way to reverse the damaging effects (Braly & Hoggan, 2002, p. 5).

Assessing Need

Living with the inconveniences of a gluten-free lifestyle is compounded by the limited availability of risk-free eating establishments when dining out. Individuals that are gluten sensitive are restricted by their diets and cannot afford the risk of casually eating at any restaurant. According to the University of Chicago Celiac Disease Center, gluten sensitive people dine out 80% less than they used to before diagnosis because they believe that less than 10% of restaurants have a good understanding of gluten-free diets ("Gluten," n.d.). In order to remain gluten-free, the customer needs to know the ingredients in what they are ordering, from where those ingredients are sourced, the brands and/or manufacturing facilities of those ingredients, and how their food is prepared and handled from the time it is removed from the refrigerator or pantry, to when it arrives at the table. Improper handling and cooking procedures can result in cross-contamination. Even the smallest particle of gluten can make a celiac or highly sensitive gluten intolerant individual gravely ill as levels of sensitivity vary tremendously across the spectrum. Side effects of gluten contamination range from mild stomach discomfort to hospitalization dependent on the consumer's tolerance level. Those with celiac disease are at most risk, with side effects as debilitating as rapid heart rate, anxiety, joint pain, stomach cramps, digestion issues, migraines, dehydration, numbness and tingling in the

extremities, insomnia, brain fog, and skin rashes just from one accidental encounter with gluten. The US Food & Drug Administration (FDA) defines the margin of safety of gluten consumption for celiac sufferers to be 20ppm (parts per million)—containing less than 0.002% gluten and weighing less than a single grain of rice—although some are affected by even less than 10ppm, which is equal to 9 times the weight of a human hair (Olins, 2011).

In addition to the health implications for the gluten-intolerant population, restaurants without any systems in place to avoid cross-contamination are not capitalizing on a large amount of revenue by not servicing this segment of the population. Gluten-free food and beverage product sales reached $4.2 billion in 2012, with projected revenue of $6.6 billion by 2017 ("Gluten-Free Foods," 2012).

Relationship to Design

The largest factor influencing all of the misdiagnosed and undiagnosed cases of gluten sensitivity, and the ill-prepared restaurant industry, is the lack of information and misinformation conveyed about the disease. The belief that celiac disease is still rare is popular opinion, even though scientific data points to the realization that, "more than 2 million Americans and Canadians suffer from this gluten-induced illness" (Braly & Hoggan, 2002, p. 4). With so much conflicting opinion still existing in the medical world, the only universal truth about the disease is the only way to treat and reverse it is through a strict gluten-free diet.

In the restaurant workforce, large policy and procedure manuals are the typical vehicle of transmission for teaching about food allergies and special diets. These methods, as will be explored later in the Preliminary Research chapter, are ineffective

communication tools at best, sending out mixed-messages, creating confusion, and leading to assumptions about gluten intolerance, food allergies, and dietary restrictions.

The purpose of graphic design is to communicate. Imbuing a message with deeper meaning, it relies on creation, selection, and organization of visual elements. “A graphic design solution can persuade, inform, identify, motivate, enhance, organize, brand, rouse, locate, engage and carry or convey many levels of meaning” (Landa, 2011, p. 2). Design can be powerful enough to influence behavior, clarify misinterpretations, and ignite change. Through design, the misconceptions about celiac disease and gluten sensitivity can be rectified, creating an understanding of the need for food allergen prevention in the restaurant industry.

Thesis Organization

This thesis is organized into six chapters. The Preliminary Research chapter examines social design practice as a process for field research within the restaurant industry. This includes analyzing currently used training methods, interviewing and surveying restaurant workers, and using participatory design as a means for user insight. Also, in this section, factors that influence design rules, such as content, cognitive processes, and how people learn will be examined, followed by case studies, and then a look at the psychology behind user interface design. In the Statement of the Problem chapter, the primary issues will be defined and the proposed solution will be explored. The design of the system and its included elements will be detailed in the next section: Methods. The Results chapter will investigate the usability of the interface through user testing outcomes. The final chapter, the Conclusion, will determine the success of the

system's overall design, as well as suggest alternative applications for the interface, and outline further research potential.

CHAPTER II

Preliminary Research

Social Design as a Process for User Insight

Perhaps the most reliable method to find out what a community needs is to become a part of that community. Through design for social impact, designers are not creating a solution to what *they* feel the problem is. Instead, they are immersing themselves in the environment, talking to the community to find out what the people feel the problems are in order to gain insight into how to solve those problems through a variety of techniques. In *Designing for Social Change* (2012), Andrew Shea refers to immersion as "any number of ways you may spend time with the community. For example, designers can immerse themselves by taking tours through a neighborhood, regularly visiting community leaders, conducting focus groups, and canvassing the community. Sometimes you need to fade into the background to observe, while at other times you might need to work side by side with members of the community" (p. 13). The following methods were used: Observation, Conversation, Assessing Attitudes, Using Participatory Design, and Secondary Sources.

Observation

Several different types of restaurants were visited and observed including bakeries (3), cafes (3), family-owned establishments (4), local restaurant chains (4), national restaurant chains (4), and fast-food franchises (3). Each restaurant offers a different level of gluten-free options ranging from no options to completely gluten-free establishments (see Table 1). Although access to the kitchens was not available for all restaurants, the focus of the observations was how the restaurant employees handled requests from gluten-free diners. The response was as varied as the types of establishments. As

expected, there was absence of concern for cross-contamination in the completely gluten-free kitchens and all staff was knowledgeable about dietary restrictions. The majority of the other restaurants being observed were willing to work with the dietary restrictions, but were unable to guarantee cross-contamination would not occur. At these ?establishments, the wait staff referred the customers to the manager on duty, who would then work with the customers to fulfill their requests or provide alternative menu suggestions. Some restaurants had already established separate gluten-free menus and would attempt to prevent cross-contamination, however if the food became tainted unintentionally, the owners had disclaimers printed on their menus. The wait staff at these restaurants, again, referred customers to the managers when questions arose about offerings on the gluten-free menu. There were also instances where the manager could not answer the question posed by the customer and needed to consult the chef, or read labels on ingredient packaging in order to inform the customer.

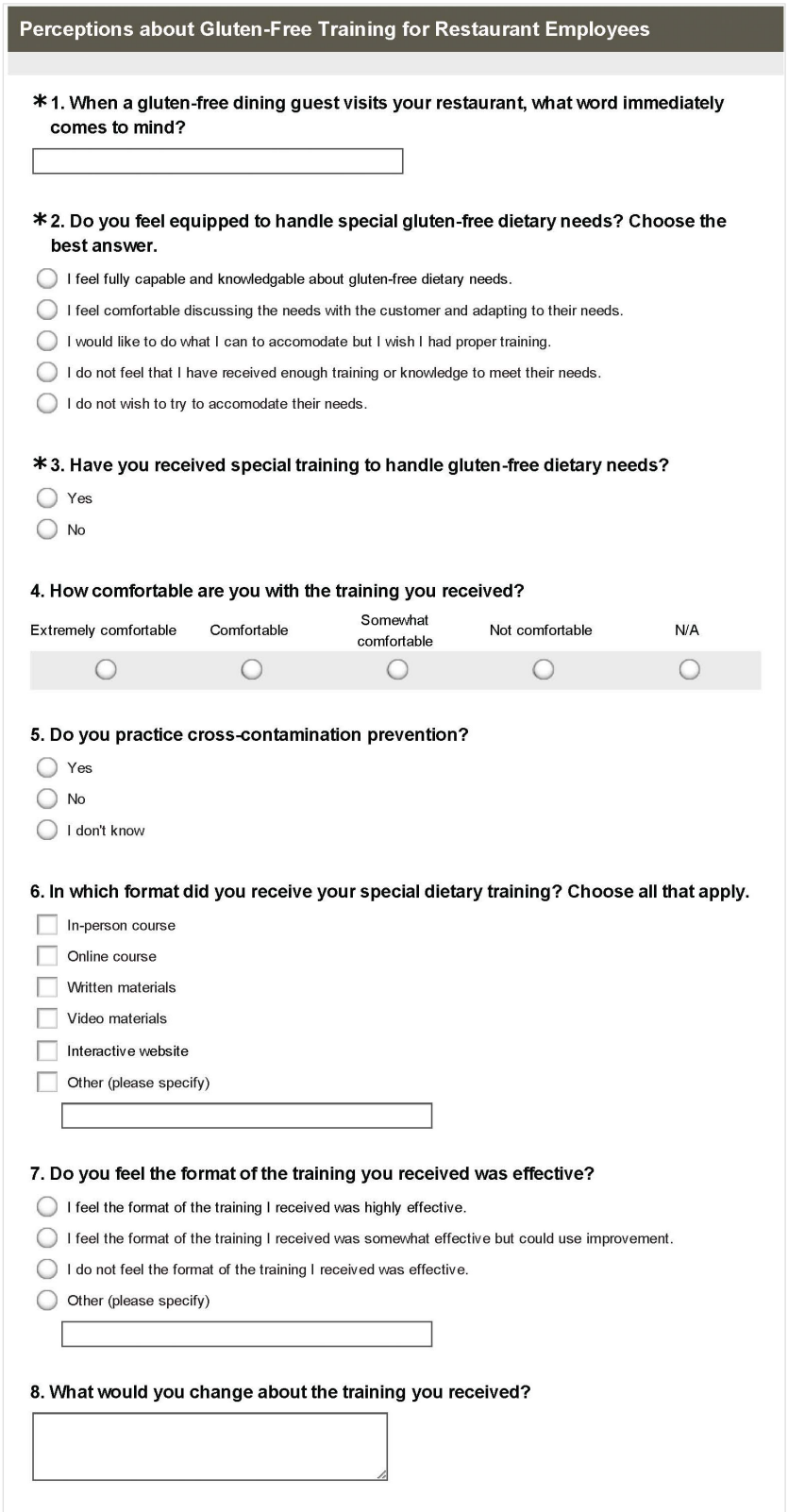
Table 1. Breakdown of Types of Restaurants Visited and Observed

Types of Restaurants Visited and Observed

		Breakdown of Restaurant Types Visited				
Types of Restaurants	**Total Quantity**	**Completely GF**	**Willing to Work with Dietary Restrictions**	**Separate GF Menu**	**Printed Disclaimer on GF Menu**	**No GF Options**
Bakeries	3	2				1
Cafes	3		1			2
Family-Owned	4	1	2	1	1	1
Local Chains	4		1	1	1	2
National Chains	5		1	3	3	1
Fast-Food Franchises	3			2	2	1

Conversation

Individual interviews were conducted with different employees at each establishment. A dialogue was developed with wait staff, managers, line cooks, and front of house to assess their knowledge, understanding, and attitudes toward gluten-free dietary needs. The majorities of the employees only knew little about celiac disease and were not aware of the foods to avoid. However, not all knew that cross-contamination could occur as easily as it does or that there is often hidden gluten in spice mixes, marinades, dressings, sauces, and even butters. There were a few waiters that did not know what gluten was, and assumed it was related to sugar because of the term's similarity to the word glucose.



Perceptions about Gluten-Free Training for Restaurant Employees

***1. When a gluten-free dining guest visits your restaurant, what word immediately comes to mind?**

***2. Do you feel equipped to handle special gluten-free dietary needs? Choose the best answer.**

- I feel fully capable and knowledgable about gluten-free dietary needs.
- I feel comfortable discussing the needs with the customer and adapting to their needs.
- I would like to do what I can to accomodate but I wish I had proper training.
- I do not feel that I have received enough training or knowledge to meet their needs.
- I do not wish to try to accomodate their needs.

***3. Have you received special training to handle gluten-free dietary needs?**

- Yes
- No

4. How comfortable are you with the training you received?

Extremely comfortable	Comfortable	Somewhat comfortable	Not comfortable	N/A
○	○	○	○	○

5. Do you practice cross-contamination prevention?

- Yes
- No
- I don't know

6. In which format did you receive your special dietary training? Choose all that apply.

- In-person course
- Online course
- Written materials
- Video materials
- Interactive website
- Other (please specify)

7. Do you feel the format of the training you received was effective?

- I feel the format of the training I received was highly effective.
- I feel the format of the training I received was somewhat effective but could use improvement.
- I do not feel the format of the training I received was effective.
- Other (please specify)

8. What would you change about the training you received?

Figure 1. Perceptions about Gluten-Free Training for Restaurant Employees Survey

Assessing Attitudes

In addition to the in-person interviews, an online survey (see Figure 1) was also created and posted on a restaurant industry forum. The survey was designed to collect information regarding special dietary training, in order to ascertain whether they had received special training, and whether they felt it was effective. The twenty responses to this survey were also varied, ranging from no training to manuals to online courses.

Some of the questions in the survey were designed to assess the employees' attitudes towards gluten-free customers. These responses were in free response format:

1. **When a gluten-free dining guest visits your restaurant, what word immediately comes to mind?** *The responses showed negative attitudes from their choice of words: "difficult," "uncertainty," "they can't expect a contamination free kitchen," and a few responses touched on what they associate gluten-free to be related to: "bread," "allergy."*
2. **What would you change about the training you received?** *The responses varied tremendously. From "more information about celiac disease," to "where do I find training regarding gluten-free diet?" Some responders even used this question as a sounding board for their obvious frustrations. Here are two examples:*

> *"I am the owner. I designed a GF [gluten-free] menu with the disclaimer that we cannot guarantee cross-prevention but we will take special precautions. We have had a huge jump in GF requests in the past five years that took a lot of time and energy to explain options and then some people ultimately choose not to eat GF. I created the menu to facilitate easy ordering—instead of training a server to recognize GF menu items,*

> *we have a menu with GF and GF options for some dishes so patrons can take it or leave it*" (Anonymous survey respondent 1, personal communication, June 6, 2013).
>
> *"None. However gluten-free eating is becoming a fad and is lessening the seriousness of those who have celiac. Kind of like crying wolf, so now no one in the kitchen cares—or very little. I work as an executive chef and have seen the terrible things that happen in kitchens. If you truly have celiac then you should stay home or only go to a dedicated gluten-free restaurant. Sorry—honest I know, but that's the reality"* (Anonymous survey respondent 2, personal communication, April 24, 2013).

With attitudes about gluten-free being what they are, it is evident there is a perception problem that stems from negative experiences and lack of knowledge. It was imperative to find out more about the training these employees had received.

Assessing Current Training Levels

In the survey, the restaurant employees were asked about the training they had each received and whether this training made them confident about their ability to handle gluten-free dietary needs. There were some discrepancies in the responses. When asked if they felt equipped to handle special dietary needs, 60% answered "I feel fully capable and knowledgeable about gluten-free dietary needs" (see Figure 2). However an overwhelming 80% of respondents said they had not received special training to handle gluten-free dietary needs" (see Figure 3). The most popular formats in which training was administered showed a split between "in-person courses," "online courses," and "written

material," although 80% responded "other" and were asked to specify (see Figure 4), citing "GF friends," "experience," "no training," and "self-taught" as common answers.

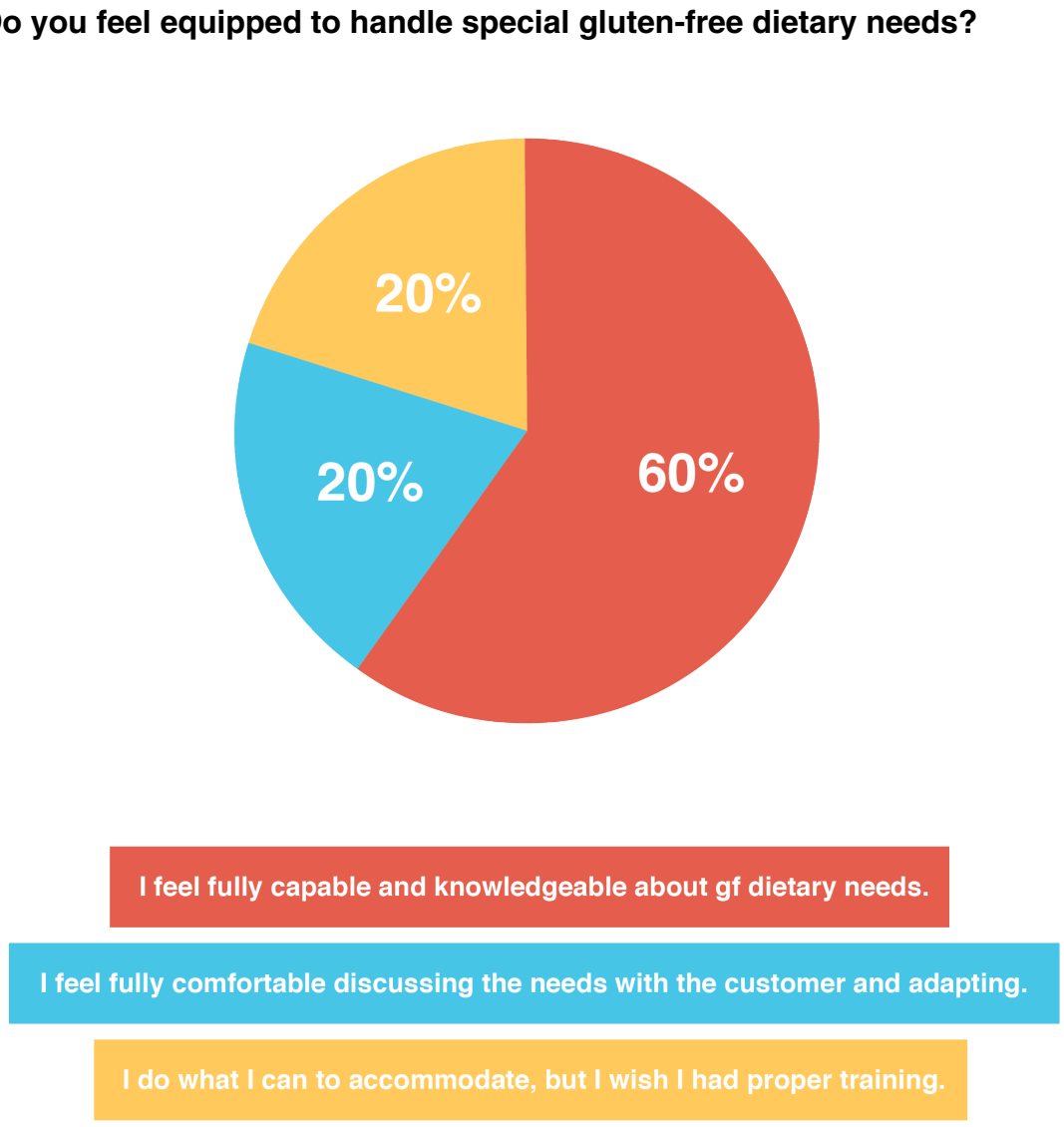


Figure 2. Confidence in Capability Survey Results

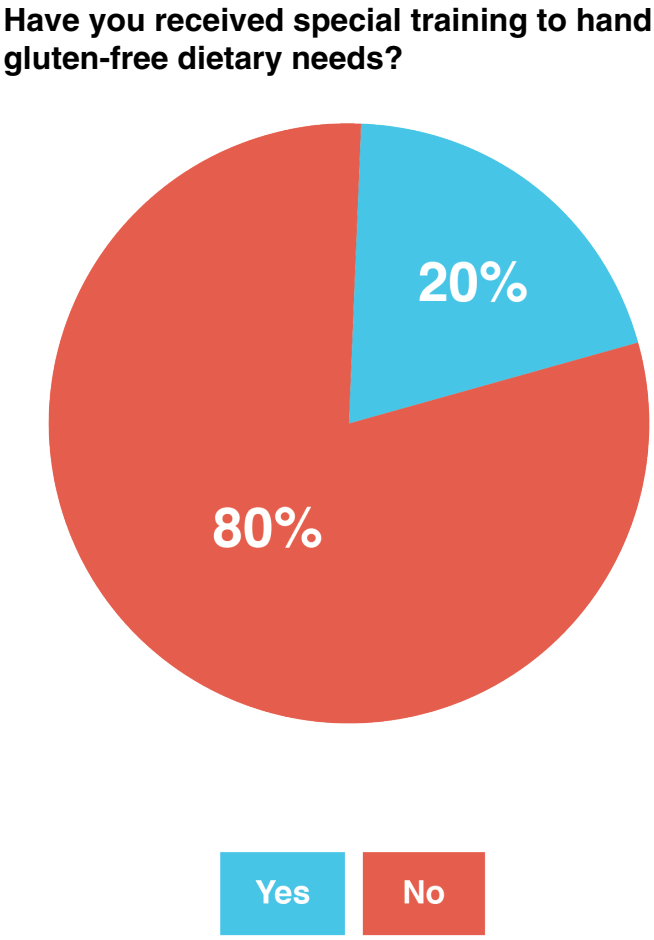


Figure 3. Percentage of Survey Responders with Special Training

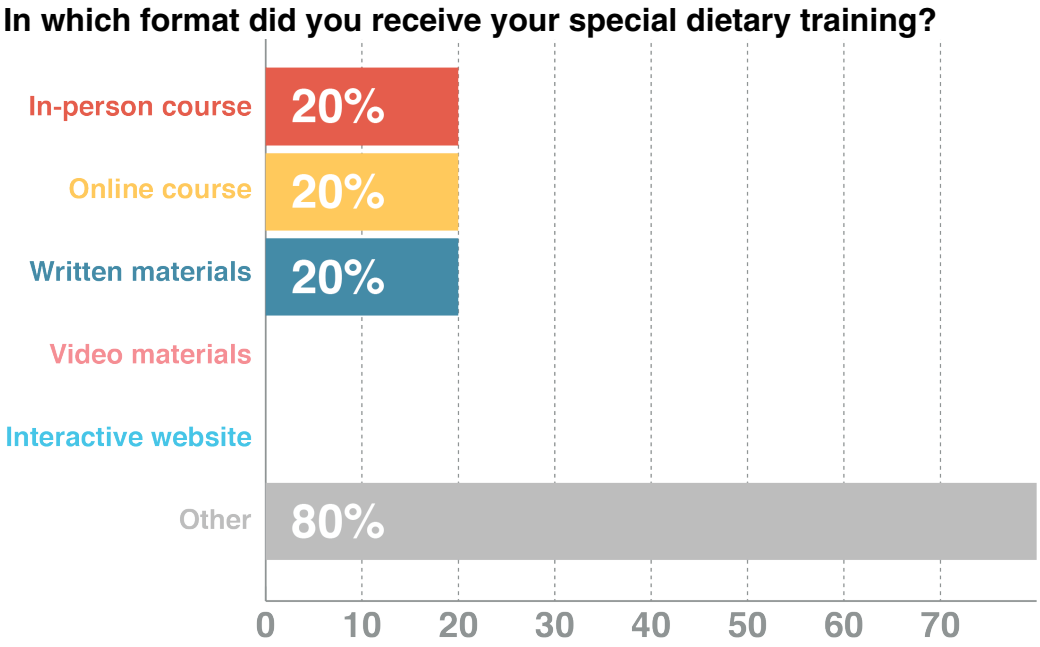


Figure 4. Training Formats Survey Results

There are some conflicting correlations when examining these data. The largest percentage of the respondents felt confident in their abilities to handle gluten-free requests, however the majority also have not had any special dietary training. Could overconfidence be a factor in why there is a problem? Cognitive psychologists have an ongoing debate about why overconfidence is so prevalent in human behavior, when history (the Vietnam war, stock market crashes, ill preparedness for natural disasters and climate change) has shown it leads to conflict, financial collapse, and ruin. "Humans exhibit many psychological biases, but one of the most consistent, powerful, and widespread is overconfidence" (Johnson & Fowler, 2011, p. 1).

Amplified personal characteristics and abilities, illusion of control over events, and denial of risk are main indicators of overconfidence bias. These over-compensations amount to errors in judgment or decision-making due to overestimating their own capabilities, and/or underestimating their opponents, the complexity of tasks, or possible

associated risks (p. 2). A recent *Forbes* online leadership forum article, "Three Ways Overconfidence Can Make a Fool of You," states, "people tend to overuse information and data that support their current beliefs," failing to analyze what is really happening and not acknowledging the fact that they could be wrong, regardless of substantial information that proves otherwise (Riordan, 2013).

World-renowned theoretical physicist, Stephen Hawking said, "The greatest enemy of knowledge is not ignorance, it is the illusion of knowledge" (Redd, 2012). Altering attitudes about gluten sensitivity through designed user behavior is one way to break through the barrier, as will be examined in further detail in the case studies section of this thesis.

Using Participatory Design

A key method in social design is participatory design. In participatory design, the end-user becomes involved in the research phase of the design process. It involves structuring an activity for the user to participate in that reveals more insight about the users' wants and needs than would be gained purely from observation and conversation. The activity usually takes the form of a design probe or a creative workshop, and allows the end-user to contribute something original and personal to the process.

Figure 5. Before I Die, Candy Chang, New Orleans, 2011 (Chang, n.d.).

Sometimes the participation becomes the design itself. A perfect example of this is Candy Chang’s Before I Die project. Chang, in a period of grief, began an experiment to get the public to reflect on their own lives and share their personal aspirations through writing on a chalkboard wall on the side of an abandoned house in New Orleans (see Figure 5). The phrase “Before I die I want to_________” was stenciled in columns across the wall and pieces of chalk were left out so anyone could pick one up and fill in the blanks. As the wall filled with responses like, “*Before I die I want to… sing for millions, hold her one more time, eat a salad with an alien, see my daughter graduate, abandon all insecurities, plant a tree, straddle the International Date Line, be completely myself…*,” Chang would then wash the wall clean so it could all start again. She exclaimed that through this project, “I understood my neighbors in new and enlightening ways, and the wall reminded me that I’m not alone as I try to make sense of my life.” After the overwhelming, positive response, Chang created a toolkit with stencils and a project site

to aid people in creating a wall within their own communities. There are now 300 different walls up in over 50 countries and more than 20 languages, each wall a reflection of the people from that community (Chang, n.d.).

Figure 6. Coca-Cola CMO Summit, The Colorbox Project, 2012 (Fenenbock, Gorsuch, McDonald, & Whitney, n.d.).

The participatory design exercise is also sometimes only used as a means for insight into user perceptions and behavior without the intentions of the activity becoming the design itself, but rather informing the designer what the users are drawn to aesthetically. In 2012, The Colorbox Project held a creative workshop with Coca-Cola's Chief Marketing Officers (CMOs), to gain insight into how they want their consumers to feel when they engage with the Coca-Cola brand. Through their own unique storytelling visualization model, using photography, color, fabric and human interaction, The Colorbox Project documents "storydata" that they use to "uncover hidden insights about the relationships people feel between colors and emotions." The participants are given verbal prompts, which can be types of emotions or being asked to describe how they feel at a particular moment. They are then asked to choose a piece of colored fabric reflective

of those emotions, and to pose, creating an interaction with the fabric, while being photographed in a photobooth environment (see Figure 6). The resulting portraits are indexed into a repository to be further analyzed to identify connections between human emotions and actions, and color (Fenenbock, Gorsuch, McDonald, & Whitney, n.d.).

The participatory approach taken for this project is most similar to the behind-the-scenes method used by The Colorbox Project. After establishing a rapport with the restaurant employees interviewed, the facilitator asked them to participate in a design exercise. A deck of flash cards was created: cards with visual cues; cards with different terms for gluten intolerance; cards with colors; cards with delivery platform options (see Figure 7). The test participants were asked to look through the deck, and to choose one of each type of card to reflect how they feel about gluten intolerance, represent what they want in a training system, and to gain insight into what they respond to visually. This exercise generated a "map" for each of the participants, associating their perceptions with a design solution.

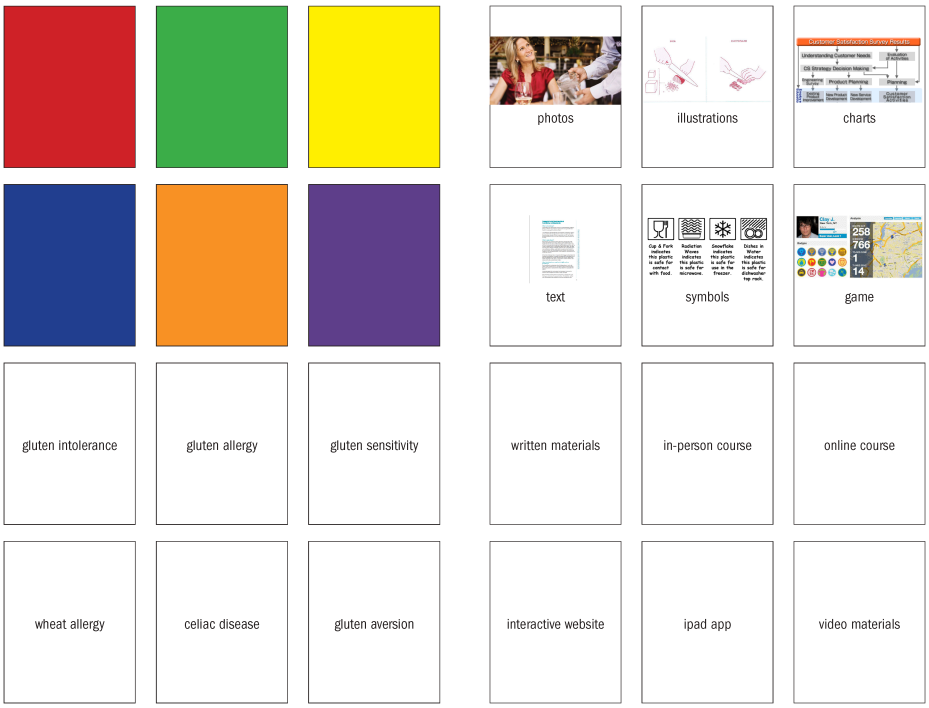


Figure 7. Participatory Design Exercise Flashcards.

One set of cards was for determining if terminology affected attitudes toward food allergies. As shown in Table 1, given the terms, *gluten intolerance*, *gluten allergy, gluten sensitivity, wheat allergy, celiac disease,* and *gluten aversion*, they were asked to choose the term that they would take most seriously when encountered during their daily duties.

Table 2. Terminology Flashcard Results

Result %	Associated Term
43%	celiac disease
21%	gluten allergy
19%	wheat allergy
13%	gluten intolerance
4%	gluten sensitivity
0%	gluten aversion

Another set of flashcards was created to qualify the preferred delivery methods of a new training system. The choices were *written materials, in-person course, online course, interactive website, iPad app,* and *video materials.* The results are shown as follows in Table 2.

Table 3. Delivery Method Flashcard Results

Result %	Delivery Method
46%	online course
25%	interactive website
17%	iPad app
8%	in-person course
3%	video materials
1%	written materials

The third set of flashcards was used to ascertain the employees' visual cue and content preferences. The options, seen in Table 3, included *photos, illustrations, charts, text, symbols,* and *games*.

Table 4. Visual Cue and Content Flashcard Results

Result %	Visual Cue & Content
33%	games
31%	symbols
20%	illustrations
11%	photos
3%	charts
2%	text

The final set of flashcards (see Table 4) were simple color cards—*red, green, blue, yellow, orange,* and *purple*—used to discover color palette preferences as well as to analyze how the psychology of color affected their decisions.

Table 5. Color Analysis Flashcard Results

Result %	Color Choices
51%	blue
45%	green
3%	purple
1%	orange
0%	red
0%	yellow

The data from the participatory design exercise delivered the acumen necessary to beginning the design process. The terminology results showed that how terms are worded affects how they are perceived. Not surprisingly, the term *celiac disease* was determined to have the most serious consequences, as it is a defined medical condition. Both *gluten allergy* and *wheat allergy* jumped ahead of *gluten intolerance* and *gluten sensitivity*

because the first two terms are associated with an allergic reaction, while just having intolerance or sensitivity to something was considered less serious. None of the participants chose *gluten aversion* as they conveyed, during inquiry as to why the term was not chosen, it was an indication of personal preference to avoid gluten rather than a necessity.

The top three delivery methods of choice were *online course, interactive website,* and *iPad app* validating a technology-based solution over traditional *in-person course, video materials,* and *written materials*.

The visual cue and content results were somewhat unpredictable. Participants were most interested in training content presented through *games, symbols,* and *illustrations* over *photos,* which they conveyed, in a post-questionnaire interview, sometimes felt "canned" or "unrealistic," especially if stock photography was being used. *Charts* and *text* were very low on the list of desired ways of receiving content, as neither are engaging methods and both require memorization of content as opposed to recall of visual cues or learning through interaction.

The color analysis results indicated an overwhelming majority of users prefer *green* and *blue* over *purple, orange, red,* and *yellow*. A recent study, "Learning in Color: How Color and Affect Influence Learning Outcomes," was conducted at the University of Arkansas to gain a "better understanding of the affective nature of color and how it influences learning attitudes and behaviors and could help training organizations design, present, and deliver effective training materials" (Conway, Goyal, Kumi, & Limayem, 2013, p. 2). The study concluded that when test subjects were shown an interface design with either a blue or a yellow background, their learning attitudes and outcomes were

affected dependent on the color shown. Color psychology has shown that people actively like blue for its calming properties, while yellow is more agitating, which is the main reason the color is used for warning signs. The results of the study showed yellow hues had a more negative emotional affect than blue hues, and this increased the participants' willingness to allow failure. The blue hues increased their attempt to avoid failure, and concurrently increased the participants' ability to recall more about the information they were taught (Conway, et al., 2013). Similarly, the results of the color analysis exercise conducted for this project, were also in line with the "Learning in Color" study findings. Preference was shown to the cooler *blue, green,* and *purple* hues for their relaxing, pleasing affect, and the warmer *orange, red,* and *yellow* hues were evaded for their distracting nature.

Secondary Sources

A vital part of designing for a community is to identify and reach out to secondary resources related to the audience and to the topic of research. Within these secondary sources, experts can help enrich the understanding of the audience and the topic, and guide designers down paths they might not have explored otherwise. Secondary sources can act as liaisons between the designer, the community partner, and the media, since the majority of these sources have already established their own media presence.

For this project, contacts were obtained within the food service industry and the non-profit foundation circuit. Interviews and meetings were arranged with the heads of local non-profit chapters, as well as email correspondence with national organizations. The agencies contacted include: The Gluten Intolerance Group of North America (local & national chapters), Texas Restaurant Association, Food Allergy & Anaphylaxis

Network, National Restaurant Association ServSafe® Program, Celiac Disease Foundation, The Mayo Clinic, and The University of Chicago Celiac Disease Center. Through these contacts more information was gathered about food allergies in general, celiac disease, and existing restaurant training programs and materials.

Analyzing Existing Training Methods

Examination of the various types of training materials restaurant employees are currently administered revealed they all have several things in common. The training materials are all written materials (either printed or onscreen) that require thorough reading. The problem lies in the fact that humans are innately wired for language, but not reading. Reading is something that needs to be learned and not everyone has the same experiences and opportunities to achieve a natural reading level. Context-heavy reading is difficult, taxing, and should not be used as a means to convey guidelines, rules, and protocols. Feature-driven reading—the ability to recognize shapes and basic features—is automatic. The sequence of cognition states that our brains read shapes first, colors second, and content last. By reducing the amount of content or changing it to read visually instead of verbally, the immediate recognition makes for a more effective learning tool (Johnson, 2010, p. 33–50).

Another commonality with current training programs, is that the training is taught in a top-down manner with no consideration for personal knowledge or experience level, and does not capitalize on already learned behaviors and routines of restaurant employees. Automating tasks builds off already conditioned responses to common kitchen procedures, further diminishing the learning curve for the new tasks being taught. A system with a bottom-up approach learns about the users' existing knowledge and

experience levels and starts the training off at the right level for each user (Johnson, 2010, p. 119–127).

Successful implementation of existing training systems relies on the employees' ability to recall the training information. Recognition and recall are two functions of long-term memory. Recognition happens when a perception occurs that is similar to a previous one and the context is close enough that it stimulates neural activity. This is valuable because we assess situations very quickly. Recall, contrastingly, is the memory reactivating old neural patterns without immediate similar perceptual input. In other words, there are no clues to trigger the right memory, which increases the response time and the likelihood for mistakes. The chance of error is greatly reduced by using recognition cues to elicit neural processing and activate the correct information, instead of relying on the user's ability to recall the correct memory (Johnson, 2010, p. 109–117).

Factors that Influence Design Rules

Content

In his final interview before his death, acclaimed American Modernist designer, Paul Rand, said, "Design is the method of putting form and content together. Design, just as art, has multiple definitions; there is no single definition. Design can be art. Design can be aesthetics. Design is so simple, that's why it is so complicated" (Lewandowski, n.d.). The content to be used in the design often dictates the design itself. Each medium has limitations on the amount of content it can convey successfully. Content-heavy applications should ideally be reserved for print, however with the onset of widespread internet research and online learning, rich amounts of content are viewed on computer

and mobile screens everyday. The challenge rests in keeping the design interactive and interesting while distributing mass amounts of content.

Processes

In *Exposing the Magic of Design: A Practitioner's Guide to the Methods & Theory of Design Synthesis*, Jon Kolko (2011) delves into the processes of design synthesis, "a way of thinking about complicated, multifaceted problems with a repeatable degree of success" (p. 170).

There are too many methods of design synthesis to cover in this thesis, therefore this paper is only describing the methods applicable to the process for this project.

Affinity Diagramming is the process of organizing the raw data collected to show relationships to one another, finding patterns and connections to synthesize ideas (Kolko, 2011). For this method, each piece of ethnographic data collected through the social design process of this project was studied. Every time there was a meaningful or surprising observation, that piece of data was written on a post-it note. The notes were then randomly hung on a wall and analyzed (see Figure 8).

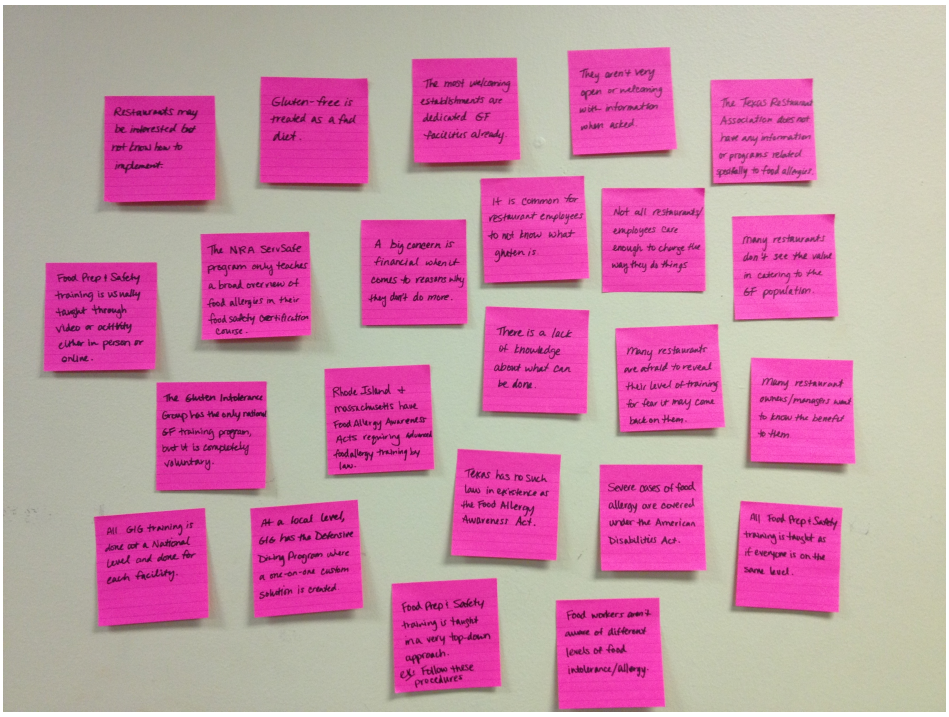


Figure 8. Affinity Diagramming: Randomizing the Data.

As connecting threads were observed between the data, the notes were physically organized into groups (see Figure 9) and new notes of a different color were added to categorize each grouping (see Figure 10). By creating these contextual containers, a larger picture of the scope of the research was obtained that provided the opportunity to define the problem.

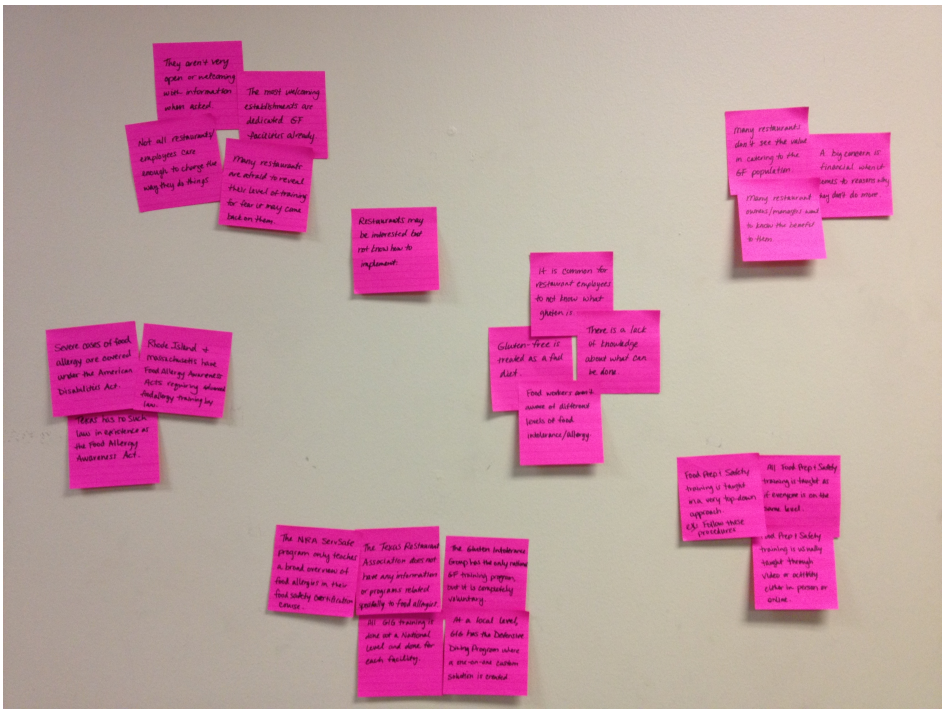


Figure 9. Affinity Diagramming: Grouping the Data.

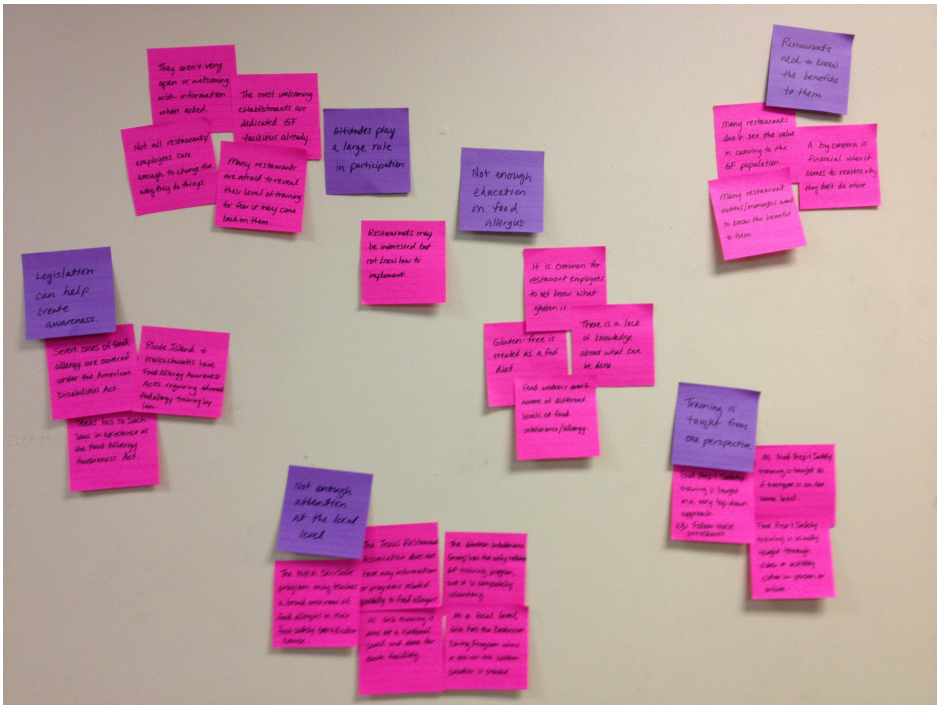


Figure 10. Affinity Diagramming: Categorizing the Groupings.

Figure 11. Taxonomy of Terms Generated by the Researcher.

Another method of design synthesis used during this project, *Concept Mapping*, is used as a tool for sensemaking—making meaning out of data. According to Kolko, "the concept map itself represents the creator's mental model of a concept, but it also informs and shapes the mental model as it allows designers to see both the holistic scale of the concept and also critical details within the concept" (2011, p. 105). The concept mapping process begins with creating a taxonomy of terms, a hierarchical classification of words related to the topic (see Figure 11). The list of words is then analyzed, prioritized, and refined until the fundamental terms are identified and used to create an armature, a primary sentence using both nouns and verbs to create a goal statement for the project.

The armature arrived at for this project is “Better gluten-free food preparation training in the restaurant industry is necessary in order to prevent cross-contamination.” The armature is then divided up into separate terms that link together, yet can also stand alone and branch off connections to other related terms, creating the concept map (see Figure 12).

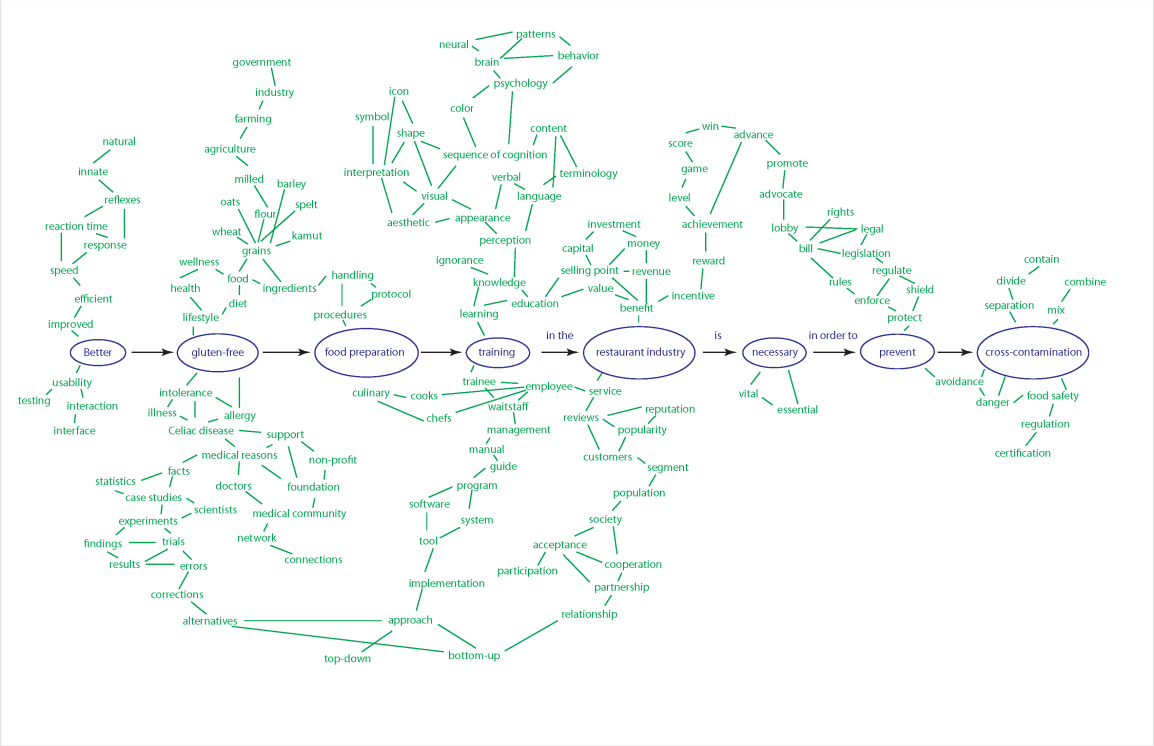


Figure 12. Concept Map.

The concept map builds an experience framework, shifting perspective through a form of storytelling that translates all of the collected information into semantic knowledge valuable for finding a design solution.

Psychology

One of the largest factors that affects design rules is the psychological construct of how people learn and process information. Award-winning author and psychologist,

Howard Gardner, theorizes in *Intelligence Reframed: Multiple Intelligences for the 21st Century*, that people possess different kinds of intelligences that work independently of one another to learn and process information from various disciplines. Gardner's multiple intelligences are: spatial, linguistic, logical, kinesthetic, musical, interpersonal, intrapersonal, naturalistic, and existential (1999). According to his theory, as we encounter different types of information, our cognitive intelligences shift to match the incoming data but some forms of intelligences are stronger than others for different people. For example, one person could have stronger kinesthetic and musical intelligences creating their ability to respond with whole body movement and to perform, like a dancer, while another is more linguistic and logical and uses language and mathematics to communicate and solve problems, like a psychologist. The bearing of recognizing that humans have multiple intelligences rests in the realization that not everyone should be taught in the same manner, because they do not learn in the same manner. One-size-fits-all education does not afford us the opportunity to live up to our greatest learning potential.

In *Design for How People Learn*, Julie Dirksen discusses the importance of identifying the learning gaps between your users' current knowledge level and where they need to be to be successful. There are different types of learning gaps to look for and questions to ask to help identify them:

1. *Knowledge gaps:*
    - What information does the learner need to be successful?
    - When along the route will they need it?
    - What formats would best support that?

2. *Skill gaps:*
    - What will the learners need to practice to develop the needed proficiencies?
    - Where are the opportunities to practice?
3. *Motivation gaps:*
    - What is the learner's attitude towards the change?
    - Are they going to be resistant to changing course?
4. *Environment gaps:*
    - What in the environment is preventing the learner from being successful?
    - What is needed to support them in being successful?
5. *Communication gaps:*
    - Are the goals being clearly communicated?

(Dirksen, 2012, p. 20).

Determining these learning gaps is essential to tailoring the designed learning experience to engage wary learners and to cater to current skill levels. In order to keep beginning learners engaged it is necessary to leverage what they already know, allow them some early success when challenged, and create safe places for them to test the boundaries and fail.

As the designer, it is vital to understand your learners' context and to realize that they are different from you and have different learning abilities. Various levels of proficiency should require adjusting levels of effort for novices, intermediate users, and experts. Novice users require lots of guidance, a very structured experience with gradual progression of difficulty, immediate, achievable goals that build self-confidence, and

continuous coaching and feedback. These elements can be scaled back for intermediate users, allowing them more autonomy throughout the learning process and the ability to practice advanced concepts. Expert users enjoy full autonomy, help with measuring progress, and the opportunity to parlay their gained knowledge into acting as a resource by teaching or coaching others (Dirksen, 2012).

Effective designed learning experiences help learners establish a sense of self-efficacy, a "belief in their own ability to succeed" (Dirksen, 2012, p. 222). Methods for developing self-efficacy include breaking up instruction by limiting and chunking the flow of information into groups of manageable data, allowing opportunities to practice and become proficient before moving onto other material. Offering structured periods of rest and the ability to always see their next goal and their measured progress are also ways to keep the user engaged.

The ultimate goal of designing for learning is to influence or change human behavior. As seen in the following Case Studies section, it is possible for design to affect people to the point that it changes their perceptions and beliefs, and modifies their existing behavior patterns, creating a truly visceral experience.

Case Studies

In 2009, Volkswagen and agency DDB Stockholm created a campaign to get people to take the stairs instead of the escalator at a Swedish train station. To entice the public to use the stairs, they had the staircase transformed into piano keys that produced sound as each riser was stepped on by the commuters ("Piano Stairs"). The campaign successfully modified the commuters' typical daily behavior, as there was a 66% increase in the average number of people who opted to take the stairs daily.

In a study conducted at the University of Michigan, groups of students were issued two identical lists of tasks, one list printed in *Arial*, an easy-to-read font, the other in *Brush*, a more difficult-to-read font. The study sought to discover if legibility of the list of tasks affected the students' perceptions of how easy or hard the tasks were to perform. The results confirmed that the students perceived the tasks printed in the *Arial* sans serif font to be easier and quicker to perform, while they believed the tasks printed in the *Brush* script font would take more effort and time to perform. The typographic choices therefore influenced the students' perceptions about the tasks' difficulty levels, when in fact they were the exact same list of tasks (Song, 2009).

A study conducted at Stanford University's Persuasive Technology Lab aimed to reveal how users evaluate the credibility of websites. The study gathered and analyzed comments written by the 2,684 participants to find out if layout, typography, color schemes, white space, and imagery factored into the perceived credibility of the site. The results of the study showed "when evaluating the credibility of a Web site, participants commented on the design look of the site more often than any other Web site feature, with 46.1% of the comments addressing the design look in some way" (Fogg et al., 2003, p. 5). The users' perceptions were influenced more by the above aesthetic elements of the user interface design than by the functionality or content of the site.

The Psychology Behind User Interface Design

As seen in the above study, user interface design can successfully alter user perceptions and modify behavior when the design triggers a reaction on a cognitive level. To create this type of user experience it is imperative to understand the psychology behind user interface design. In *Designing with the Mind in Mind*, Jeff Johnson identifies the

cognitive and perceptual science that is at the core of user interface (UI) design rules. These UI design rules are a set of guidelines based on human psychology that are applied and interpreted to the design of user interfaces. There have been numerous lists of guidelines created by various authors over the decades, however since they are all based on cognitive psychology, the lists share the majority of the same rules:

- Create consistency and standards
- Aim for universal usability
- Offer informative feedback
- Design task flows to yield closure
- Prevent errors
- Permit easy reversal of actions
- Let users feel they are in control
- Minimize short-term memory load
- Provide online documentation and help

Having spent his entire career pairing UI design with psychology, Johnson teaches how to model the task to generate the greatest outcome by using human behaviors and perceptions as keys to designing successful interfaces (2010). Modifying behavioral patterns is essential in user experience design when the end goal is to get the users to adapt to new methods in their current regimens. Implementing new procedures and protocols for allergen cross-contamination prevention into current daily routines requires modifying the existing behavior of restaurant employees to allow for the correction of old tasks and the implementation of new ones.

According to Johnson, in his "We Perceive What We Expect" chapter, our perceptions are biased by our experiences, current context, and our future goals. These biases need to be considered and designed for accordingly. Our past experiences prime us to expect to see things similar to what we have seen before and in the same locations we previously saw them. For example, users frequently click buttons without really reading them. They are accustomed to seeing "Back" and "Next" buttons in the same positions on a site. If their positions were switched, the users would still click them expecting the correct actions, and there would be a delayed reaction before they realized the content was moving in the opposite direction than expected. This same methodology applies to teaching task-based behavior. The learning curve for new tasks is diminished by modeling the new material after already learned behaviors, for instance, teaching a prep cook an entirely new method for preparing a meal would be counterproductive, whereas making modifications to the usual prep routine would require minimal effort and memorization while producing the same result. "When a system closely matches the tasks humans have to perform and care has been taken concerning memorability, the need for extensive training is reduced. Hence, the time and costs are reduced" (Welie, 2001, p. 22).

Bias based on current context occurs when surrounding factors affect the perception of the material being learned, creating subconscious associations. "Perceptions in any of our five senses may affect simultaneous perceptions in any of our other senses" (Johnson, 2010, p. 5), meaning what we see can be affected by what we hear, smell, taste, touch, and vice versa, such as when a particular scent triggers a memory from childhood. This affects the importance of considering the design of the entire learning experience, to

ensure optimal absorption and retention of the material through creating positive associations. In other words, making sure there are cognitive triggers for activating the correct memorized information when the users need to recall and apply what they have learned.

People tend to filter out and gloss over elements unrelated to their future goals by scanning screens quickly, similar to how we can tune out background noise to focus on a conversation. Understanding users' end goals when designing interactions is essential to creating an effective user experience. If the users' end goal for this system is to earn a certification in food allergen prevention training, then all of the interactions they need to complete should lead them to their end goal.

Our brains respond to visual hierarchy and the *Gestalt* principles of design, "laws of perceptual organization that govern visual thinking" (Landa, 2011, p. 31). Johnson outlines the following *Gestalt* principles and describes how they are applied in user interface design:

- *Proximity*: Objects close together appear to be grouped together. Proximity is applied to layout of control panels and data forms.
- *Similarity*: Objects similar in appearance appear to be grouped together. Similarity is applied to dialog box items, menus, and text fields.
- *Continuity*: Human vision perceives continuous forms, filling in missing data. Continuity is seen in slider controls, perceived as a "single range controlled by a handle that appears somewhere on the slider, not as two separate ranges separated by the handle" (p. 16).

- *Closure*: Human vision perceives whole objects, mentally closing in open figures. Closure is usually applied to graphical user interfaces (GUIs) that represent a stack of objects. In reality, we only see one whole object and the edges of others, however our brains tell us that the objects behind are also whole objects.
- *Symmetry*: Our brains parse complex images into simplified shapes with an equal distribution of elements. Symmetry is at work when we view three-dimensional images on a two-dimensional screen.
- *Figure/Ground*: Our brains separate the visual field into foreground and background. Figure/Ground is applied when placing a background behind content or when using pop-up windows to display more information.
- *Common Fate*: Objects that move together appear to be grouped together. Common Fate is applied in "animations to show relationships between entities" (p. 22).

These *Gestalt* principles always work together in user interface design. For instance, Common Fate and Similarity are applied when a user highlights groups of files or folders on the desktop and then drags them to the trash (Johnson, 2010).

Our visual system is optimized to perceive structure. Humans scan for relevant information and need hierarchy to make sense of the data. Without structure, the user is forced to scrutinize the content to find what they need, which greatly affects the usability of the site. Breaking the content up into labeled sections, using different font sizes and styles, and utilizing the *Gestalt* principles are all ways to get the users to focus on relevant information and to build a positive user experience. All of these techniques will

be implemented into this system to not only create a pleasing aesthetic experience, but to also create the most effective learning tools based on how the mind processes information.

Applying the psychology behind design rules is essential to developing an effective learning experience. When the design is in line with the functionality of the human brain, the learning curve for adapting to the user interface is shortened; therefore users can spend more time concentrating on the lessons being taught.

CHAPTER III

Statement of the Problem

Food safety and handling training is commonplace in the restaurant industry, however the information covered usually refers to preventing food borne illness from bacterial sources and keeping kitchens compliant with health inspection codes. Allergen training is often in the form of supplemental information containing only a general overview through standard food safety courses. For more in-depth training to deal with allergies and special diets it is often upon the restaurant owner to seek out at an extra expense. The resources available for this "special training" are limited, typically administered and overseen by select non-profits and foundations for celiac disease. As an alternative, restaurants may try to educate themselves on gluten-free dietary needs in order to spare the cost of additional training. To their own detriment, through these actions they are not learning proper protocols, as there is a vast amount of contradictory information about cross-contamination prevention.

Secondly, when allergen training is available, the information is taught in a manner that produces less than optimum results. Training materials are often in the form of extensive reading material and guidelines without consideration for personal experience, previous knowledge, or behavior patterns. The success of the training is also dependent on the user's ability to recall the information learned without being prompted by perceptual clues, which increases the likelihood for error, as they are solely reliant on memory.

The lack of interactivity in the training process also prevents users from becoming engaged with and developing a relationship with the material. The absence of this

emotional and visceral connection precludes the ability to modify user perceptions and behavior patterns therefore the users are not really learning and evolving their thinking from the process. The restaurant industry is a customer service based business, and daily interactions require conversation, connection, and understanding.

A new approach to food allergen prevention training needs to be developed to inform, educate, change existing beliefs and behaviors about gluten intolerance, and reduce the risk of cross-contamination in commercial kitchens. The system needs to actively engage the user and hold their interest as they strive to achieve their end goal: certification in food allergen prevention.

Hypothesis

Through the exploration of interaction design based on psychological factors, a system will be developed to change the approach to gluten allergy training. The design solution will be an interactive training system for desktop application. Through the use of task-based training, interactivity, storytelling, and gaming elements, the system will generate a personalized experience to actively engage the users in learning, reward them for performance, and offer incentives for furthering and/or refreshing their training skills.

The objective is to improve food allergen education for restaurant employees by designing a user experience based off of cognitive psychology and how it informs user interface design decisions. Through simulation learning, users will learn about gluten intolerance and methods for cross-contamination prevention and why they are important in commercial kitchens. Through a series of informational sets and interactive activities, they will understand the need for cross-contamination prevention and how their actions affect gluten-free diners. Challenges will be presented throughout the training to test

users on their retention and understanding of the material. The users will need to pass each challenge with an appropriate score before they can move forward in the training level. They will be given opportunities to repeat challenges and improve their scores until they reach the required amount of points for passing.

The beginning assessment and training Level 1 will be prototyped and administered for user testing to gain insight into usability, user preferences, and the perceived effectiveness of building a bottom-up approach to training—customizing the learning experience to the users' knowledge and experience levels. The user assessment portion of the training program will be used to gauge and customize the training to each user with consideration for past experiences, current knowledge, and attitudes toward gluten intolerance. The Level 1 training will provide information about celiac disease, gluten intolerance, and cross-contamination through use of factual knowledge, icons, and interactive activities and challenges.

CHAPTER IV

Methods

The training system interface will be constructed using the following methods and included elements: User Interface Design, User Experience Design, Storytelling, and Gamification.

User Interface Design

There are fundamental heuristics in user interface design (UI) that increase the usability of a website. The most important of these is knowing and learning about the users, identifying their goals, and focusing the design on helping them achieve those goals. Straying from the intention of the site and adding superfluous elements not only detracts from the usability of the site; it affects the users' perceptions of the site's credibility as well. As internationally recognized interaction design and educator, Stephen Anderson (2011) explains, "the user interface design decisions we make affect the perceived personality of our applications" (p. 26). All design decisions should have a reason to support them that influences the users' path towards their end goal. The focus of this training system is to reduce and/or eliminate the chance of gluten cross-contamination in commercial kitchens, therefore all included elements should aid in achieving that goal through a series of task-based activities and challenges.

The user interface separates the user from the backend functionality and code that builds a website. It hides the magician behind the curtain, and the most effective interfaces not only divert attention away from what is hidden behind, but also become invisible themselves. In an article in *A List Apart*—an online magazine dedicated to web standards and best practices, Pär Almqvist (2000) writes, "an invisible interface allows

the user to focus on performing a task, and not on how it should be performed. An invisible interface has a low or non-existent learning curve" (Creating Digital Interfaces section, para. 4). To keep the interface transparent, it needs to remain simplified and free from unnecessary elements. In his seminal book, *Don't Make Me Think: A Common Sense Approach to Web Usability*, Steve Krug (2006) asserts that the UI design of a website should be intuitive to the user to the point that thinking about how to use the interface is not required (p. 11). Choices about sizes, colors, and placements of elements should be consistent across the design and their functionality needs to be self-evident to the user.

When mapping out the design for the training system, there were several considerations in deciding the imperative elements for the site. First and foremost is identifying the site through consistent and prominent placement of the system's visual identity. The logo and name of the system is placed in the top left corner of all pages of the site as well as in the top, centered position of modal windows. These locations both place the site identity (ID) at the top of the visual hierarchy because the logo and name frames everything underneath it, making the rest of the design and the content inherent to the site ID (see Figures 13a–b).

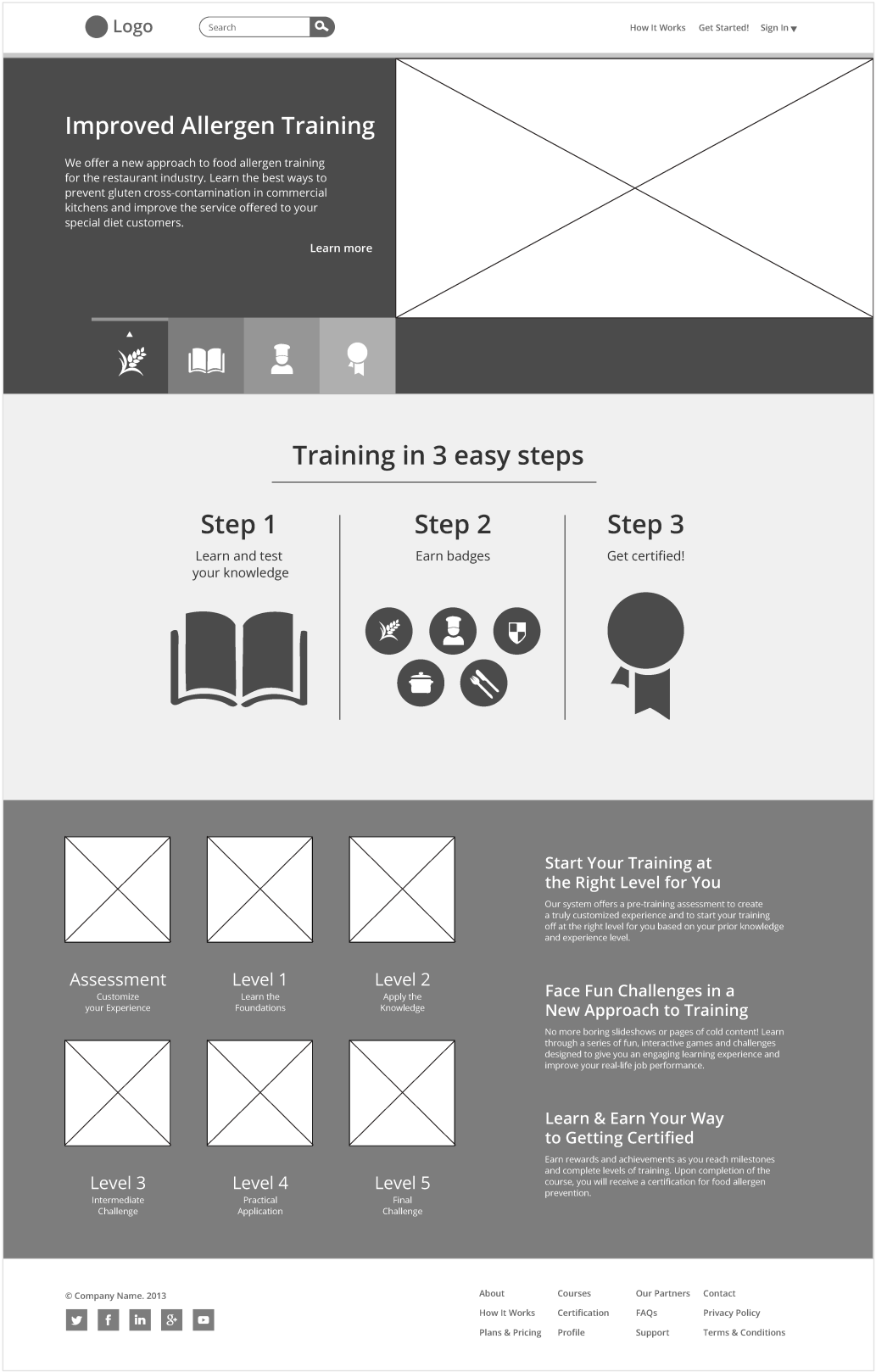


Figure 13a. Overall Hierarchy of Homepage.

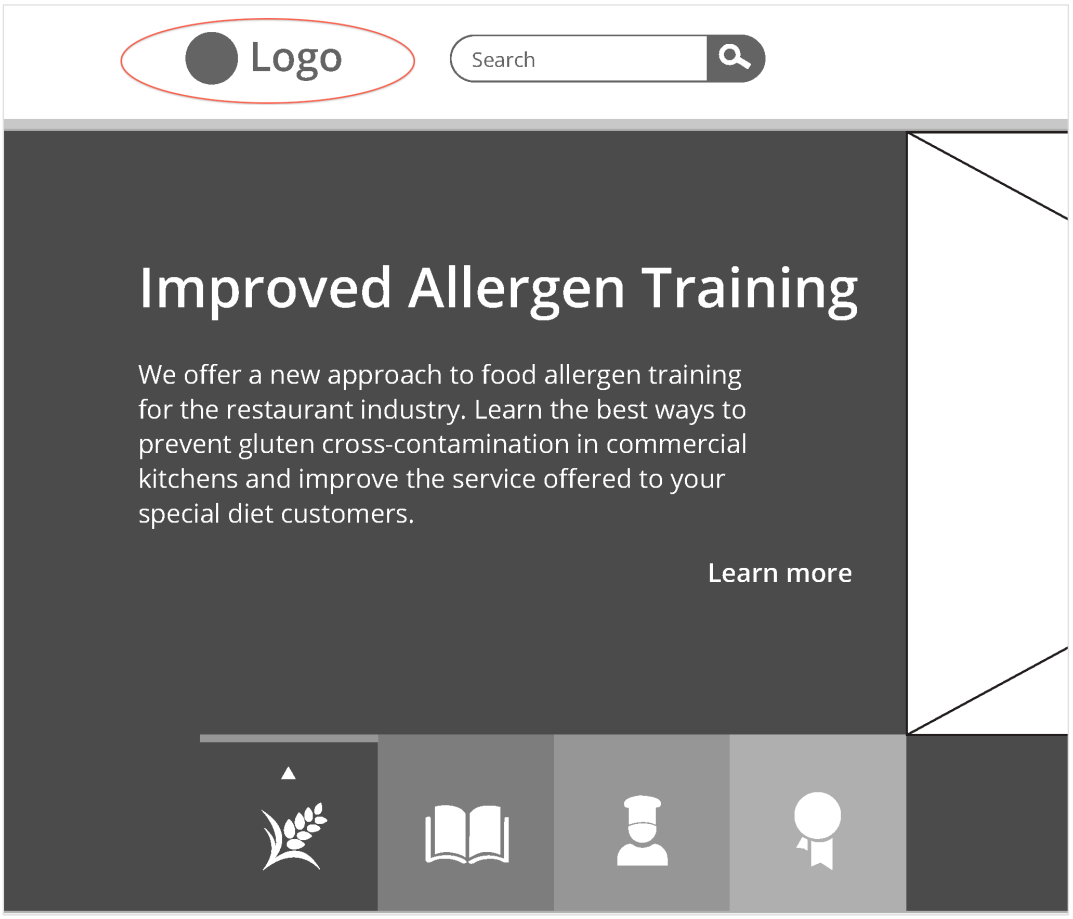


Figure 13b. Detail of Site Identity.

The site navigation is kept very minimal due to the purpose of the system. In a learning space, it is crucial to keep the user focused on the task at hand. The training structure also prevents the user from moving ahead and jumping around between training levels, therefore the navigation is limited to a few key utility links—"How It Works," "Get Started," and "Sign In"—at the top right of the page (see Figure 14). Additional navigational links to more information about the courses, the company, frequently asked questions, and contact info are provided in the footer at the bottom of the site (see Figure 15).

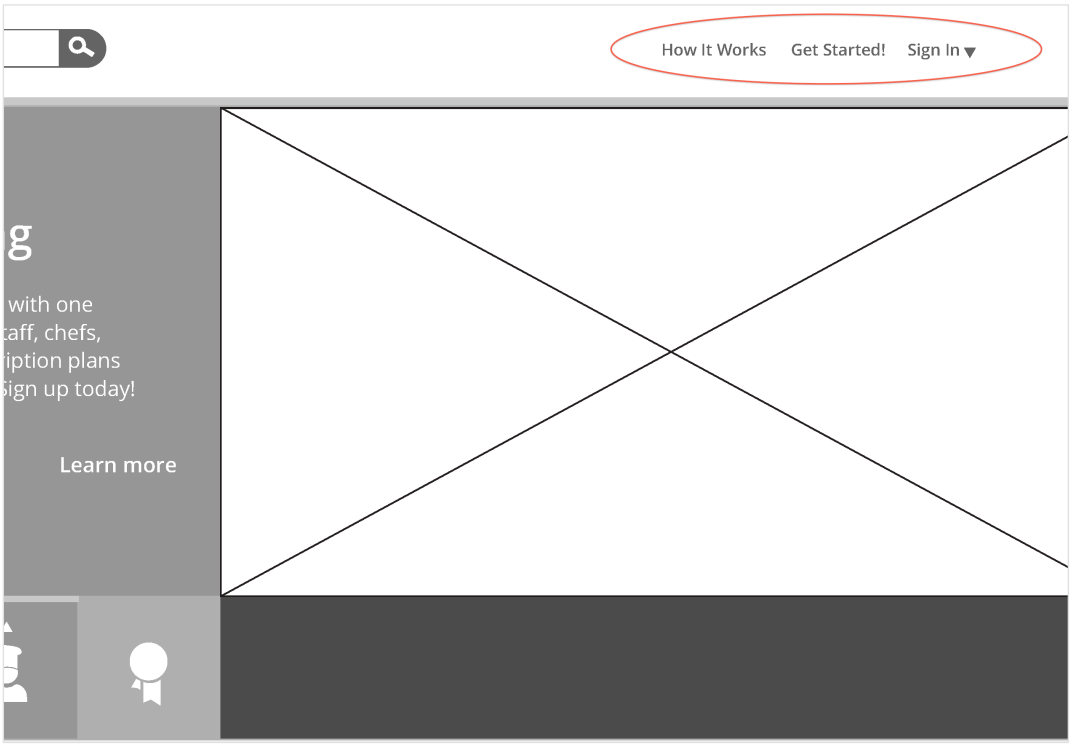


Figure 14. Detail of Utility Links Navigation.

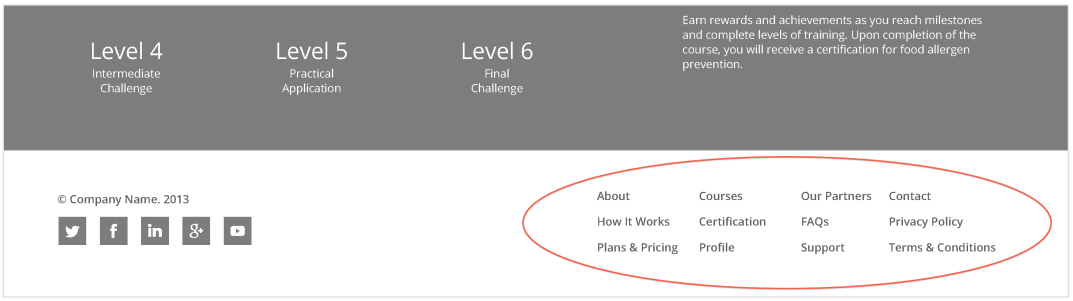


Figure 15. Detail of Footer Navigation.

Another essential component to effective UI design is providing a search feature. Krug (2006) emphasizes the fact that every page in a site should have access to a search function, and the best formula for this is to keep it simple and follow standard UI patterns with just the word “Search” and a box for users to type in their search criteria. He argues against using fancy language that confuses the users and recommends that the search options be limited to create a blanket search, unless it is being conducted for a very

robust site where breaking the options down into keywords or specific sections is valuable (pp. 67–68). The search feature for this training system is consistently located to the immediate right of the site identity and the top of every page of the site so users can have access to this function at any given point (see Figure 16).

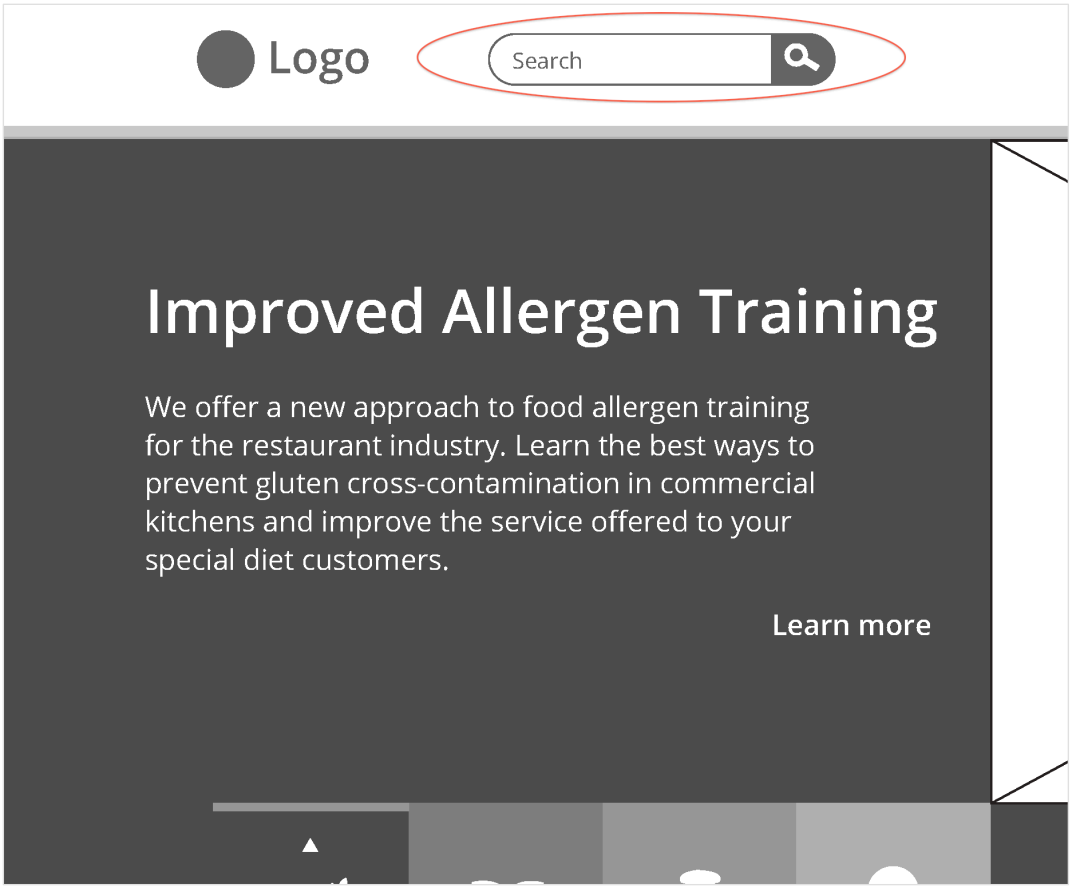


Figure 16. Detail of Search Feature.

First impressions are everything, thus the homepage needs to instantaneously communicate the purpose of the site. In order to achieve this, the hero—a main focal point graphic placed at the top of a web page that gives the user a place to start when scanning the screen—conveys an overview of the site's content. In this case, the hero is a rotating banner comprised of tabbed rollovers that each reveal an aspect of the site, a

short synopsis of that aspect, and an accompanying image for each (see Figure 17). For the purpose of the wireframes, the "X" is used as a placeholder for future images.

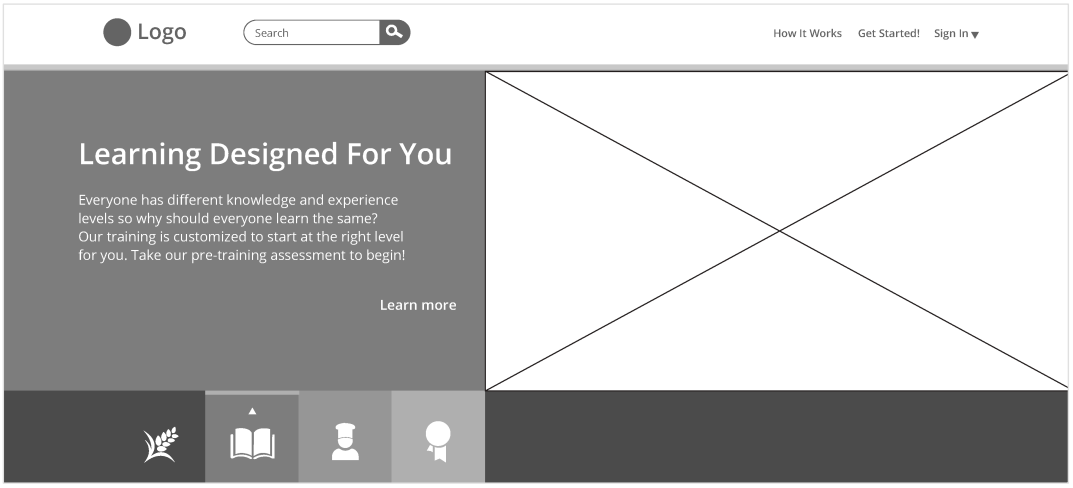


Figure 17. Detail of Homepage Hero.

Underneath the hero, the training steps are broken down into visuals:

- Step 1: "Learn and test your knowledge"
- Step 2: "Earn badges"
- Step 3: "Get certified"

Simplifying the training steps into visual representations allows the user to grasp the functionality and procedural steps of the system at a quick glance (see Figure 18). Below these icons, the levels of training are displayed along with a few short blurbs about how the training works (see Figure 19). Through keeping the design simple and uncluttered, and only presenting necessary information in a clear visual hierarchy, the users' first impression of the site reveals what the site is and what it does quickly and effectively.

Figure 18. Detail of Training Steps Breakdown.

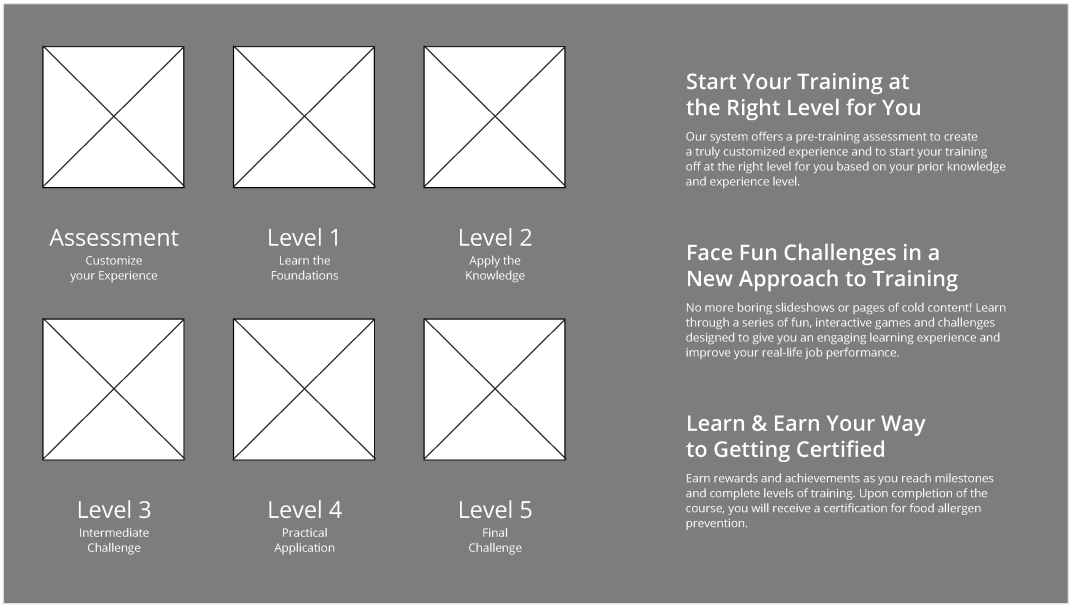


Figure 19. Detail of Training Levels Breakdown.

The subpages of the site fall under different constraints, as the layouts of the pages are different dependent on the content. Consistency is achieved through creating hierarchy

with the use of font size and placement of elements. The page names and headings of the site sections are always displayed at the top of the page underneath the site ID, search and navigation. They are always in the largest font size on the page to make it clear that all of the content is framed underneath in the structure of the page (see Figures 20a–b). When functional elements, such as buttons, are used from page to page in different sections, the placement of those elements remains consistent as much as possible to make the navigation through the site easier for the users (see Figure 21).

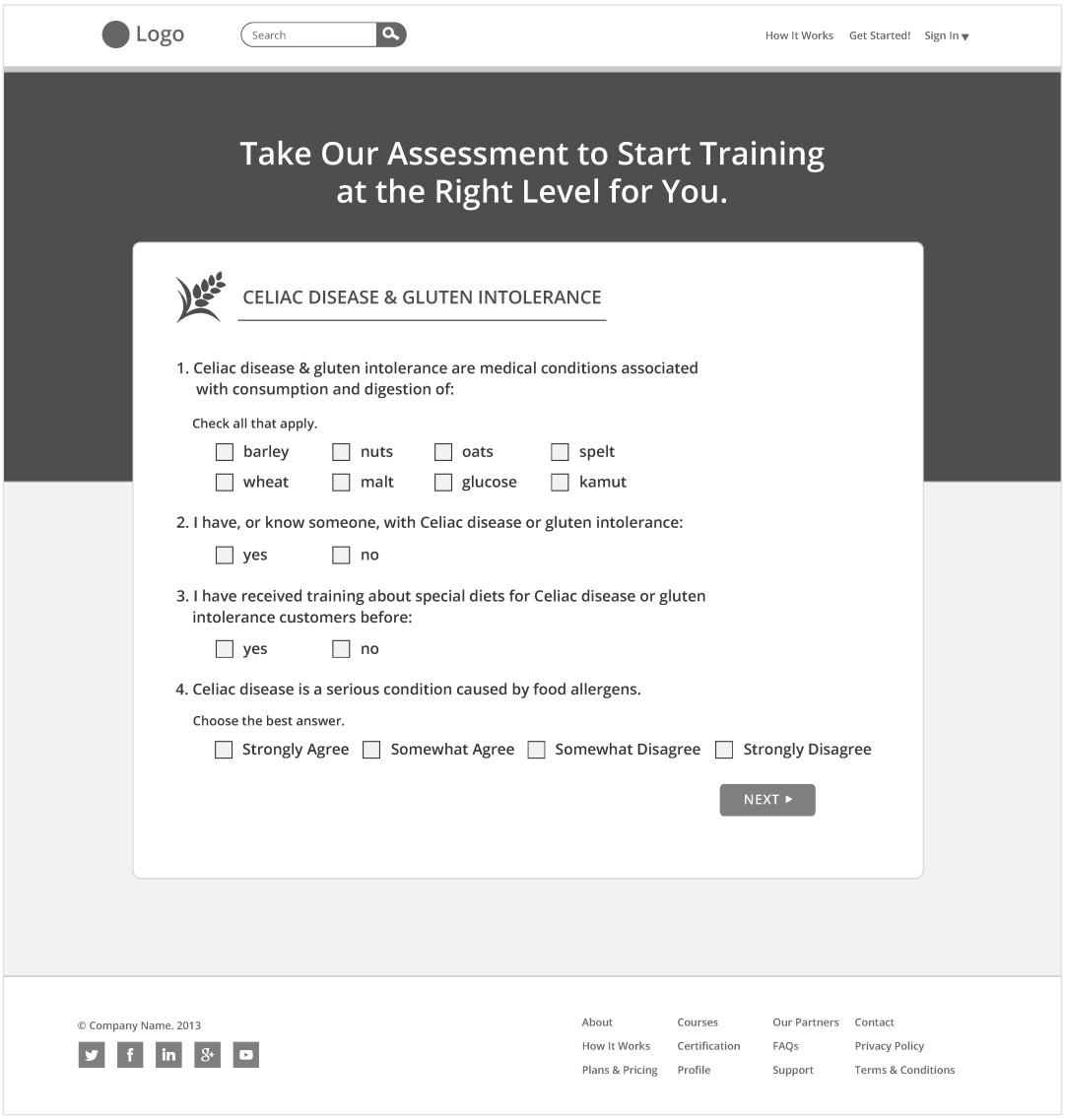


Figure 20a. Overall Page Structure of Subpages.

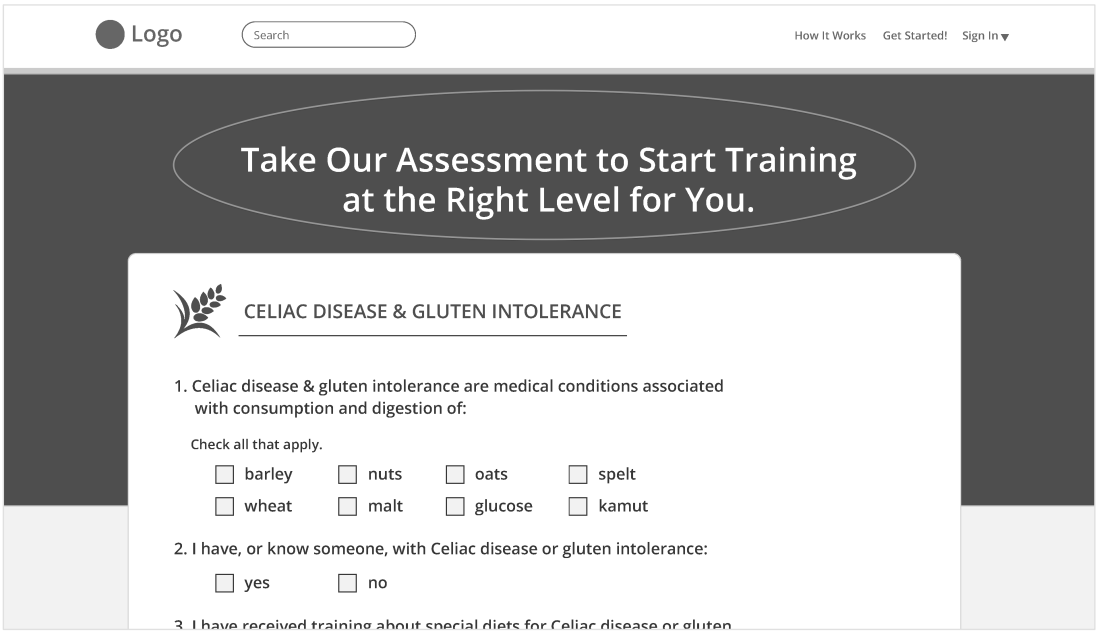


Figure 20b. Detail of Page Name Hierarchy.

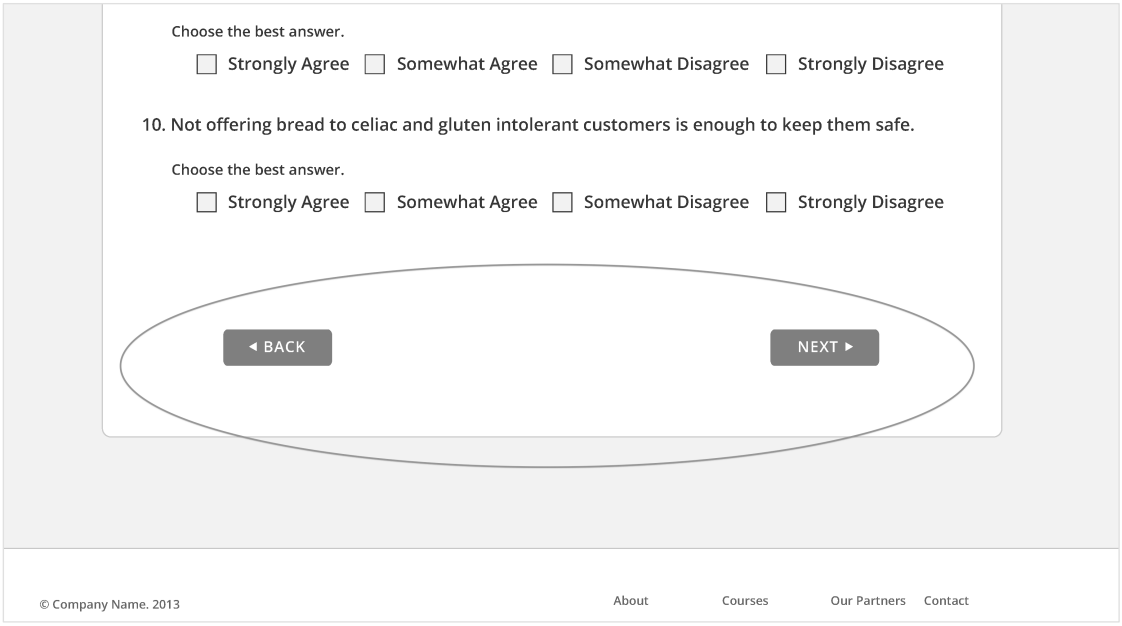


Figure 21. Detail of Site Buttons.

There are some instances where the users will encounter modal windows; child windows that open overtop the parent application. These windows usually contain dialog boxes that require the user to complete an action (i.e. signing in to the site), or convey messages

to the users. When a modal window appears the system content underneath will darken, letting the users know that it has been disabled until they complete whatever action is necessary in the modal window (see Figure 22).

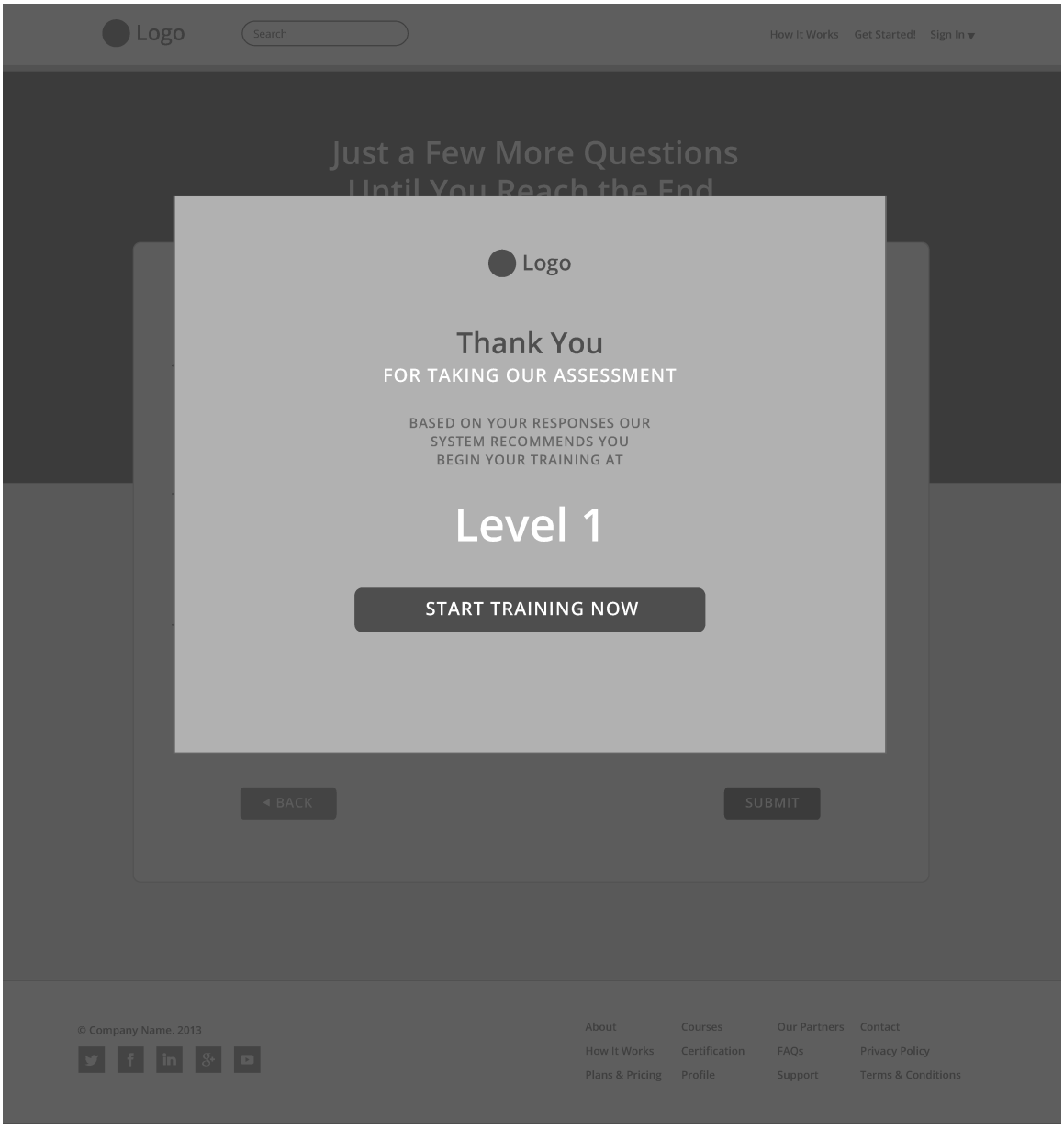


Figure 22. Modal window.

As new pages are created for the site and their content changes, the layouts and functionality will change as well. Some pages will have more content than others, some

will require the inclusion of media, and some will be designed for game play, however using consistent visual hierarchy is a way to tie them all together in the UI design.

User Experience Design

As Stephen Anderson proposes in his book, *Seductive Interaction Design: Creating Playful, Fun, and Effective User Experiences* (2011), there are six levels of maturity that need to be reached in his *User Experience Hierarchy of Needs* model. The first four steps are achieved through the UI design. Starting at a functional level, by making the interface useful. Secondly, the user needs to feel that the site is reliable by establishing credibility. The next two levels are ensuring the application is both usable and convenient, meaning finding the most natural behaviors to create interactions (i.e. drag and drop). The fifth step to be achieved is to create a pleasurable experience for the user by establishing flow.

Czech psychologist, Mihaly Csikszentmihalyi, the first to theorize and define the term *flow* as it applies to cognitive psychology, describes the phenomenon as an "automatic, effortless, yet highly focused state of consciousness" (as cited in Kolko, 2011, pp. 50–51). Flow is the sensation humans feel when they are deeply engrossed in a task to the point that they lose sense of time and lack of concern for self, such as forgoing meals because they are so focused on their activity. A recognized expert on the subject of user experience design, Phillip Harris (2013) suggests, "flow is the perfect link between user and product, where thoughts, actions and results all seem to merge in that positive stream" (UX Psychology II section, para. 10). Flow is achieved when users feel challenged and the task they are performing is difficult enough to require concentration without being overwhelming. Dirksen (2012) defines "keeping people on that edge

between challenge and ability" as the chief guiding principle for flow (p. 198). For this training system, an attempt to create flow will be made by offering the users small, achievable goals to allow them early successes, which then lead to larger goals. Building the users' self-efficacy and gradually increasing the difficulty of challenges as they progress will keep the users actively seeking to win, improve, and learn throughout the training process.

The final level in the *User Experience Hierarchy of Needs* model is to craft a meaningful user experience through shifting user behavior, prompting emotional resonance, and getting the user to care about the consequences and outcomes of their actions (pp. 11–13). Interactive activities designed to make the users reflect on their actions through seeing how they affect others are a unique part of this training system.

As explained by Anderson (2011), "usability clears the way for a good experience by eliminating troublesome interface distractions, but a great experience stems from something more—an awareness of why people could or do care" (p. 10). Getting users to care about the content requires visceral design, designing on a gut level. Co-founder of the software company, *Mysterious Trousers*, Rob Foster defines visceral design as "that point where we release energy from a design in a way that creates surprise, delight, or simply a response that satisfies our desire to engage, manipulate, and shape our experience (as cited in Brown & Longanecker, 2013). The strategy for achieving visceral response in this training system will be through a combination of storytelling and gaming elements that transform the data from dry facts to interactive experiences that resonate with the users.

Storytelling

Storytelling is an ancient art that traverses all cultures and people. The oral tradition of telling stories has been used to educate, entertain, and pass down histories since before the advent of written language. Modern storytelling is being used as a tool for reframing and recasting information into relatable and memorable language. Storytelling is often employed in gaming and interactive platforms as a tactic to engross the users in the experience. International learning expert Karl Kapp (2012a), describes how the use of storytelling benefits the end goals of user experience:

> Storytelling within an instructional game allows learners a vicarious experience through the story, which they can apply to their work situation or learning environment. The elements that make this possible are: Characters, Plot (something happens), Tension, and Resolution. Adding these elements together creates an effective story to accompany the elements of a game. Story elements are not only engaging, but they guide the player through the game as he or she attempts to fulfill story elements and to obtain the goal of the game. (p. 42)

Using narrative to communicate, the training system will use what UX researchers, Whitney Quesenbery and Kevin Brooks (2010), refer to as *springboard stories* in their book *Storytelling for User Experience: Crafting Stories for Better Design*; springboard stories "are evocative because their goal is not to suggest a specific solution, but rather to spark the imagination and get people thinking about the problem in new ways" (Stories spark new ideas section, para. 4). Through placing restaurant service and cross-contamination scenarios in narrative context, the users will relate to the dilemmas

the personas face in the stories, and be able to think through the situations and assess the correct solutions for the bigger picture.

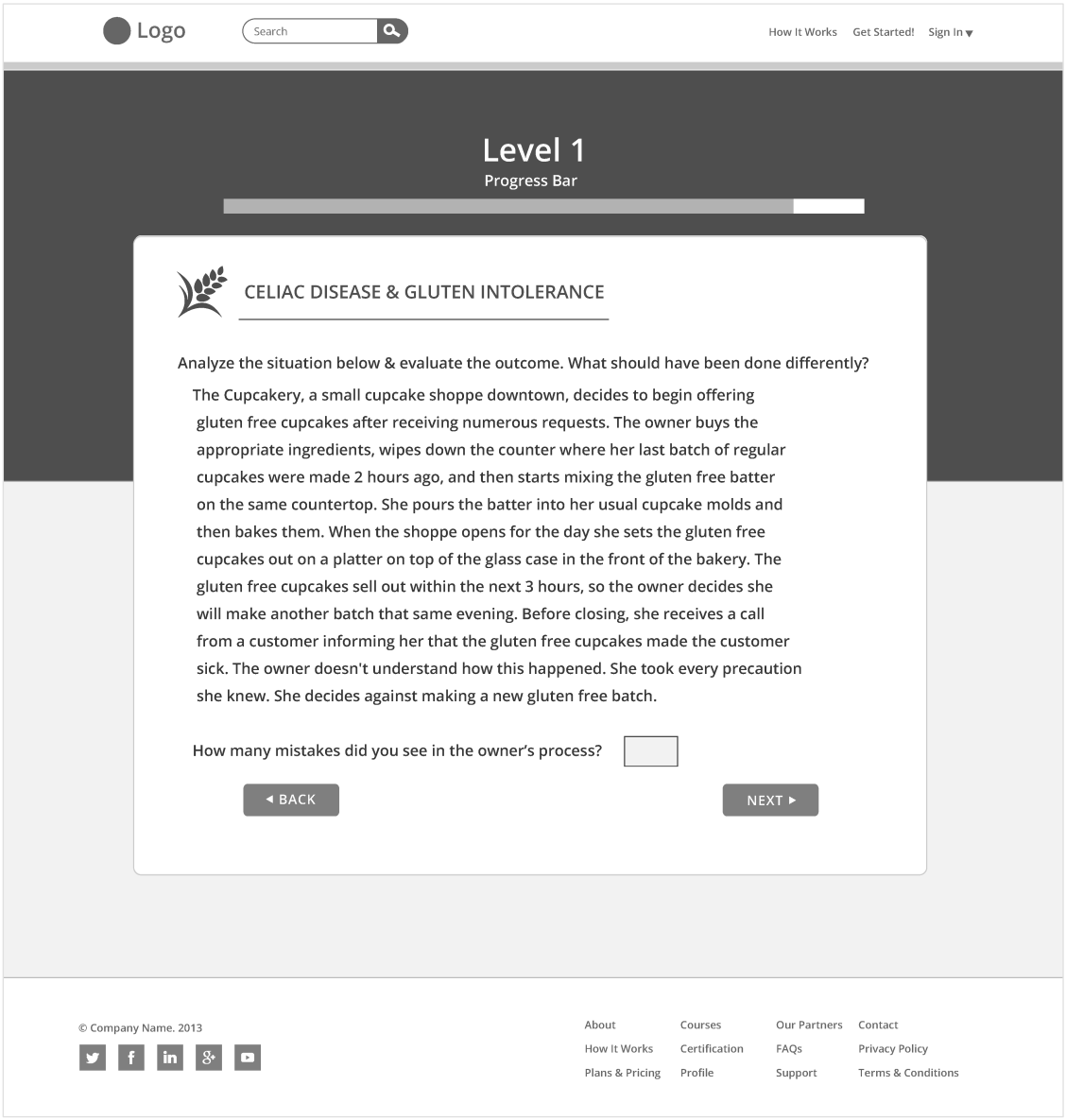


Figure 23. Storytelling example.

Storytelling is a means of personalizing the information; taking static facts and procedures and making them come alive through setting, plot, and the actions of the characters, or personas. For example, as seen in Figure 23, a story is composed to highlight how simple and common it is for cross-contamination to occur when not

properly educated in preventative methods. The story is set in *The Cupcakery*, a fictitious small town bakery. The persona—the bakery owner—decides to begin offering gluten-free cupcakes. To her surprise, the cupcakes she serves become cross-contaminated and make a customer sick, even though the owner—who was using her assumptions as knowledge—thought she was taking every logical precaution. Placing the problem in story context, users can assess the situation and determine where the owner made mistakes. The logical flow of the sequence of events is designed to make the story easier to recall later, and the emotional context associated with how the owner must have felt when she realized her customer became sick is created to resonate with the users on a deeper level than just simply stating the facts about cross-contamination. Dirksen (2012) identifies the importance of creating emotional resonance through storytelling in learning experiences, suggesting, "when we teach people facts, stripped of broader context, we make it hard for those learners to act on that information" (p. 139).

Storytelling is an essential element of gamification. Stories add relevance, meaning, and context; they elicit emotion, prompt critical thinking, and guide actions. Karl Kapp (2012a) describes well-designed educational games as games that "blend a task-related story with interactive game elements to help the player learn the desired behaviors, actions, and thinking patterns that support the desired outcome within a particular context" (p. 42). Further applications of game mechanics to learning experiences are detailed in the following section.

Gamification

Incorporating gaming elements into the new training system is a tactic for creating a more effective user experience and for increasing the frequency of the system's usage.

Achieving higher levels of engagement, modifying behavior, and stimulating innovation are the main goals of gamification. The most successful gamification interfaces create a challenge for the user to overcome, frame the game around a compelling story, and offer continual feedback on progress and advancement (Kapp, 2012b). Earning rewards and incentives, setting goals, and designating different levels of learning and play are elements that will be employed to administer the most engaging and interactive training experience to the users.

Integrating reward structures is a key element in gamifying an experience. Game play and challenges are intrinsic motivators, meaning they are performed out of personal interest and the users' pleasure derives from simply executing the tasks, but rewards and goals are extrinsic motivators—externally motivated by outside factors such as earning points, badges, and achievements (Anderson, 2011). Reward structures will be instituted in the training system through the following ways:

- Create player leaderboards so users can see how they compare to others taking the same training.
- Create team leaderboards so restaurants can compare the number of active/accomplished trainees to other restaurants also taking the training.
- Learners earn badges for each level of completed training and for special milestone accomplishments and performance.
- Once the players have earned all the badges by completing their training, they earn a cross-contamination prevention and food allergen safety certification that then becomes tangible in the real world.

The next gamification element to be utilized is goal setting. “The simple introduction of a goal adds purpose, focus, and measurable outcomes” (Kapp, 2012a, p. 28). Goals should be clear and visible throughout the gaming experience. When learners understand how far they are from a goal it provides motivation, incentive, and feedback on how they are progressing through the training. Having a series of small goals that lead to an even larger goal, established self-confidence for the users when they pass those smaller goals, instilling a desire to move forward and achieve more. When users complete levels in the training, they are achieving small goals. They are able to track their progress towards those goals through implementation of a progress bar located at the top of the training pages (see Figure 24). At any given point in the training, they can see how far they have come, and how much further they need to go for each level. This is also a manner of providing feedback to the users and letting them know that they are advancing, and improving, through the training which is designed to increase in difficulty level as they progress in the course.

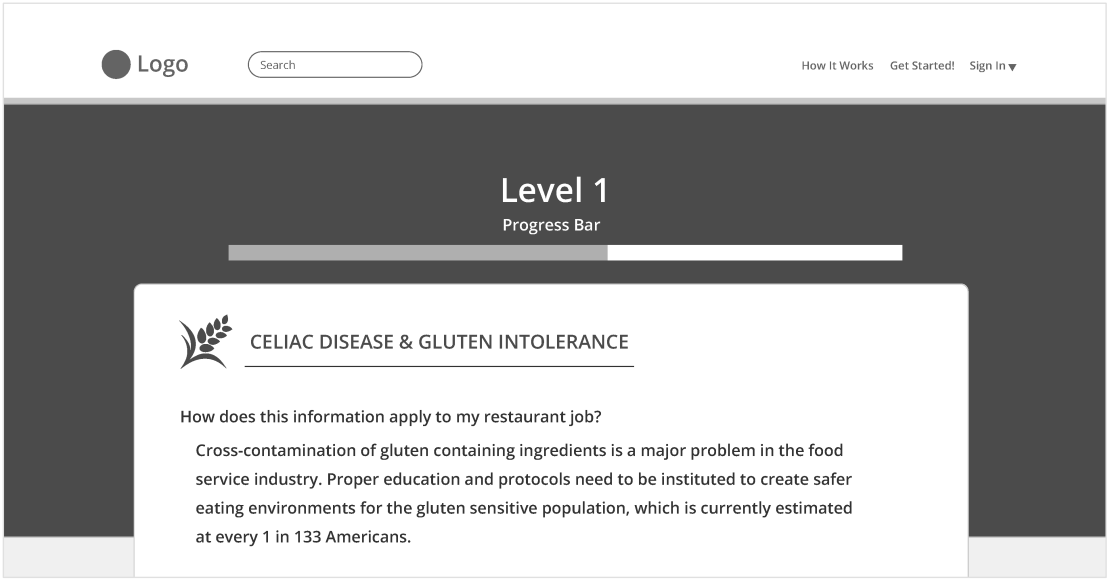


Figure 24. Detail of Progress Bar.

There are three types of levels in game playing. Levels of progress describe the users' movement through the course. Breaking up the training material into sections, the system will require the users to play through different levels that increase in difficulty as the training progresses. Users will be required to draw upon their earlier challenges to overcome bigger obstacles later in the course.

Levels of difficulty can be determined by having the learners complete an assessment test before beginning training that will determine the users' current knowledge levels, skill levels, and attitudes towards the material being taught. The users will then begin training based on the system's assessment, allowing for the course to be adjusted according to the player. This is different from the traditional top-down approach that does not take the users' prior knowledge or experience into account.

The completion of training sections measures the users' levels of experience, ranging from novice to expert. Once the users have reached expert level, and have completed the training, their level of experience transcends the virtual world and parlays into a tangible designation and certification in their real-world working environment.

When designing an interactive educational experience it is important to match gaming techniques to the learning requirements. Kapp stresses the importance that, "The knowledge that needs to be taught should dictate the design techniques and game mechanics used for gamification" (2012a, p. 166). When teaching declarative knowledge and facts, the most applicable game elements are stories, sorting, matching, and replayability. Stories help encode the information into the learners' brains. Sorting is valuable because users need to know organizing and separating, and matching links

images or ideas together. Replayability gives users the chance to play again, improve their scores, and learn from their mistakes (pp. 167-169).

Teaching procedural knowledge requires providing overviews of entire procedures, allowing the users to practice each part along the way, and then having them emulate the entire procedure from start to finish. It is vital to ensure the users are grasping the importance of how and why the procedures need to be performed, otherwise they will just be performing the steps based on memorization and not truly understand the concepts or be able to adapt to changes (pp. 181-184).

Teaching to alter attitudes, beliefs, values, and emotions is part of the affective domain. The best ways to achieve this are through encouraging participation, showing achievable goals, and immersing users in task-based activities. In a 2010 study conducted by Wei Peng, Mira Lee, and Carrie Heeter at Michigan State University, participants were asked to play an interactive game, *Darfur is Dying,* pertaining to the crisis in Darfur. The researchers were interested in observing if playing a game based on social issues had any effect on the participants' empathic reactions and willingness to help. The results indicated that participants were more willing to help the Darfurian people than those who only read about the crisis or only watched someone else play the game. Taking active participation triggered an emotional response that prompted the users to change their behavior (as cited in Kapp, 2012a, p. 186). This type of response is the agenda of this training system. Immersion of the users in task-based activities where immediate consequences of gluten cross-contamination can be seen, will activate an empathic response in the users, change their attitudes towards gluten-free diners, and increase their willingness to comply with prevention guidelines.

User Testing of Design Prototype

In *Undercover User Experience Design: Learn How to Do Great UX Work with Tiny Budgets, No Time, and Limited Support*, UX designers Cennydd Bowles and James Box (2011) explain the two general types of usability test: *summative* and *formative*. *Summative* testing is used for existing systems typically for pre-launch checks. *Formative* testing is conducted with new and unfinished systems to gain insight into improving the design (pp. 99–100). Testing for this system is formative, and looks for gaining insight into the usability, the design, the content, and the game factor. Color analysis is not included in this round of testing; since color has such strong psychological connections it is necessary to prevent color choices from clouding the user testing results, therefore the prototype is presented in grayscale so the users can concentrate on the above elements being tested. The training system is user tested through paper prototyping. When designing a game-based educational system, paper prototyping is a quick and easy way to test for playability, engagement, and learning (Kapp, 2012a, p. 216). In paper prototyping the sequential screens are printed and presented to the user testing participants, in the same order as if they were encountering the system through a digital interface. As the users interact with the paper prototypes, the pages change out accordingly. When a user "clicks" a link by tapping it with their finger, the page for the resulting content is set in front of them in place of the previous page.

The first screens encountered are the home page (see Figure 25) and the alternate stages of the home page when the user interacts with the rollovers in the hero at the top of the page (see Figure 26). From the homepage, the users click the *Step 1* icon to start their training, where the next screen begins the users' assessment prior to beginning the course

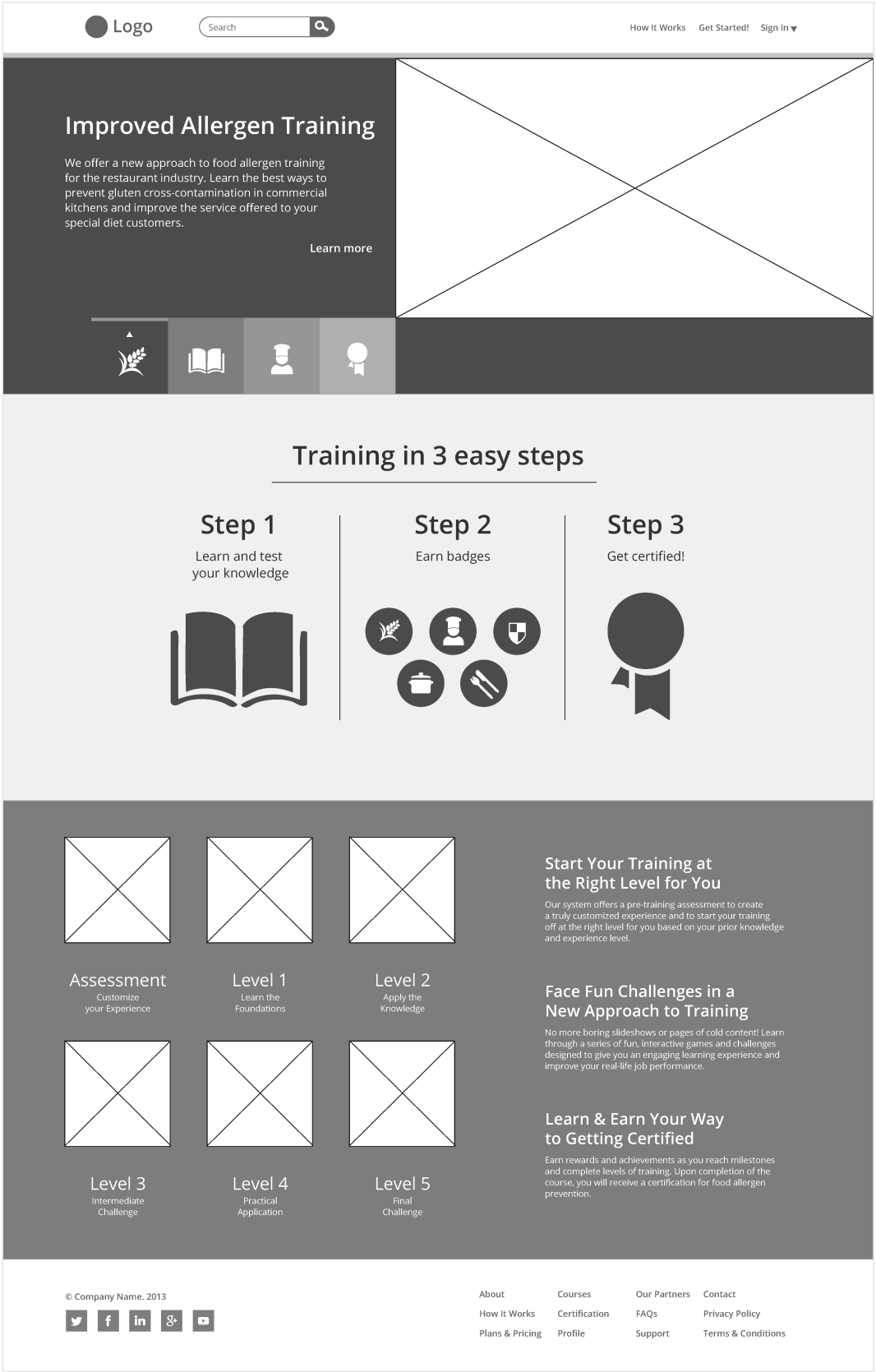


Figure 25. Homepage.

Figure 26. Alternate Homepage Heroes after Rollovers.

(see Figures 27a–d). During the test, the users fill out the checkboxes representative of their answers using a pen. Their responses are reviewed and scored; they are then presented with a modal window with a link to begin their training session (see Figure 27e).

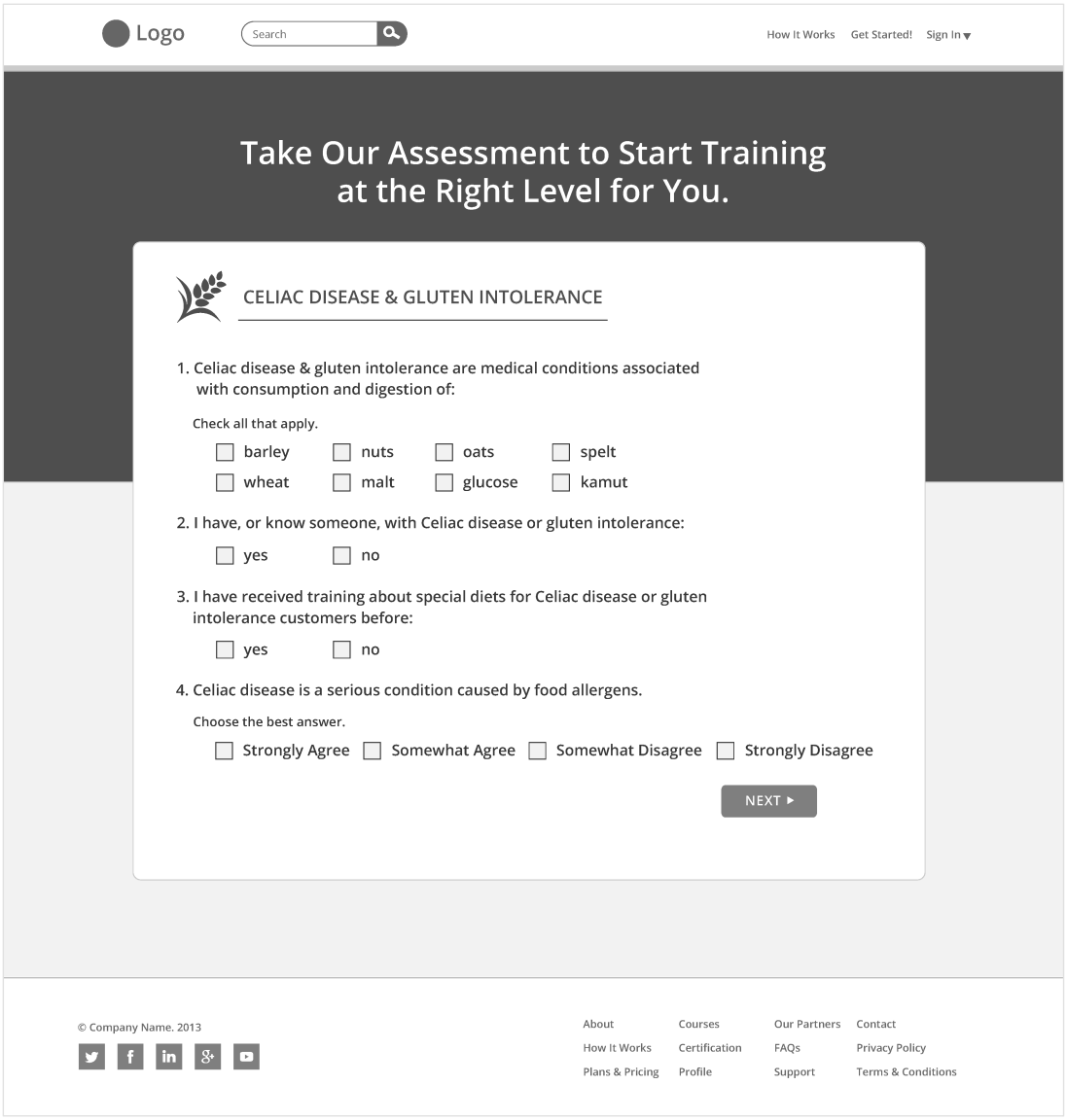


Figure 27a. Pre-Training Assessment Screen 1.

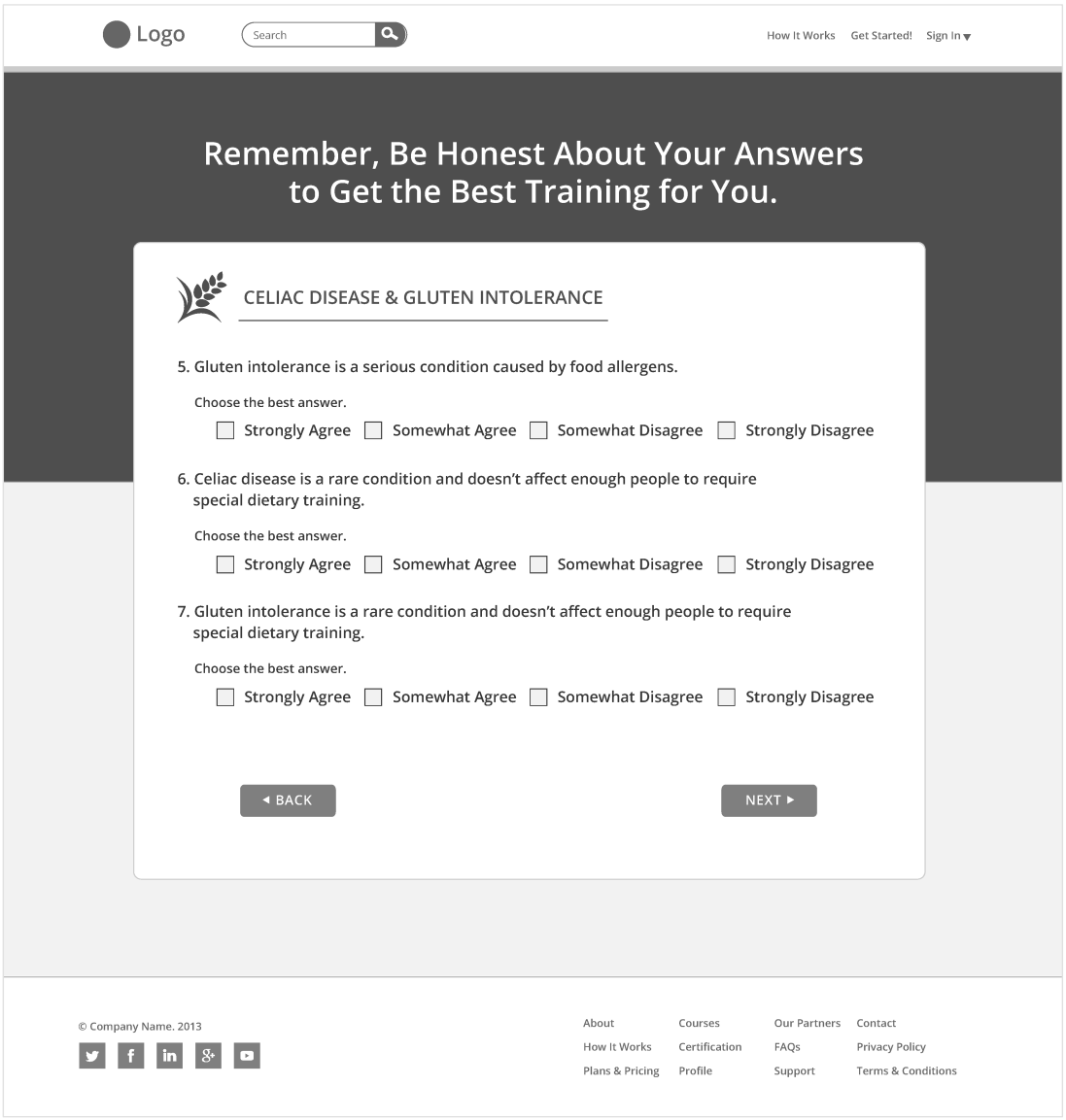


Figure 27b. Pre-Training Assessment Screen 2.

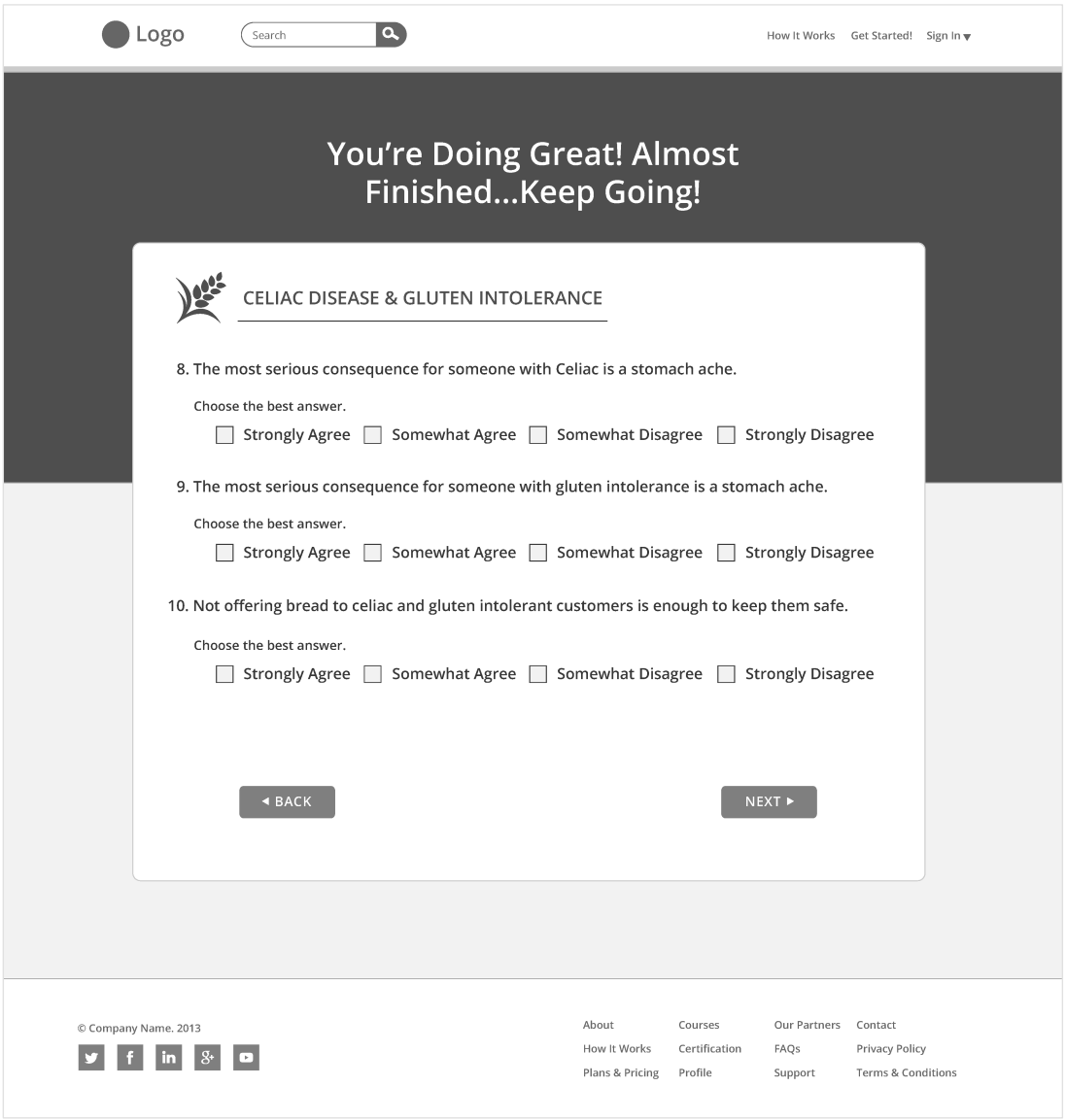


Figure 27c. Pre-Training Assessment Screen 3

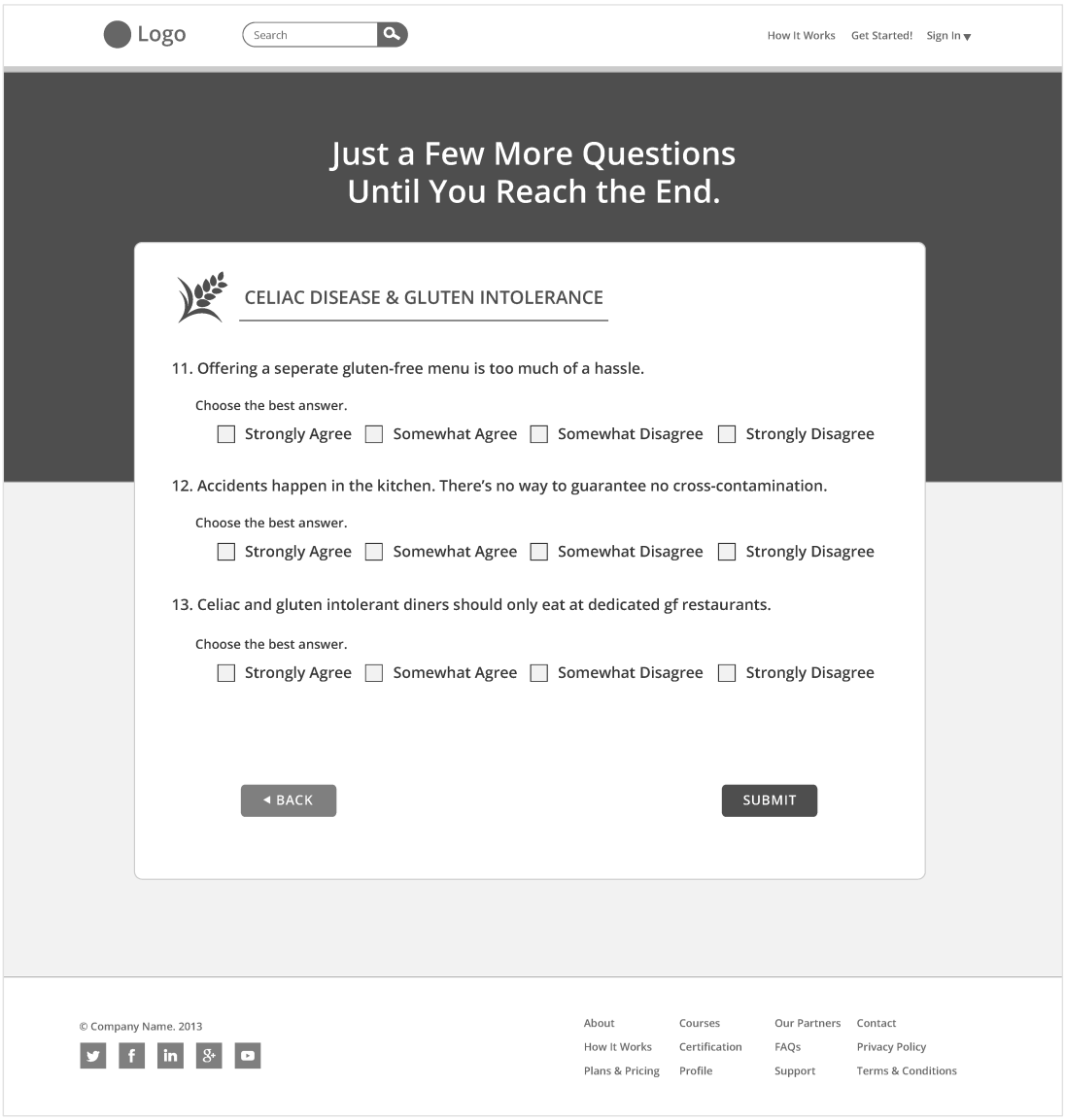


Figure 27d. Pre-Training Assessment Screen 4.

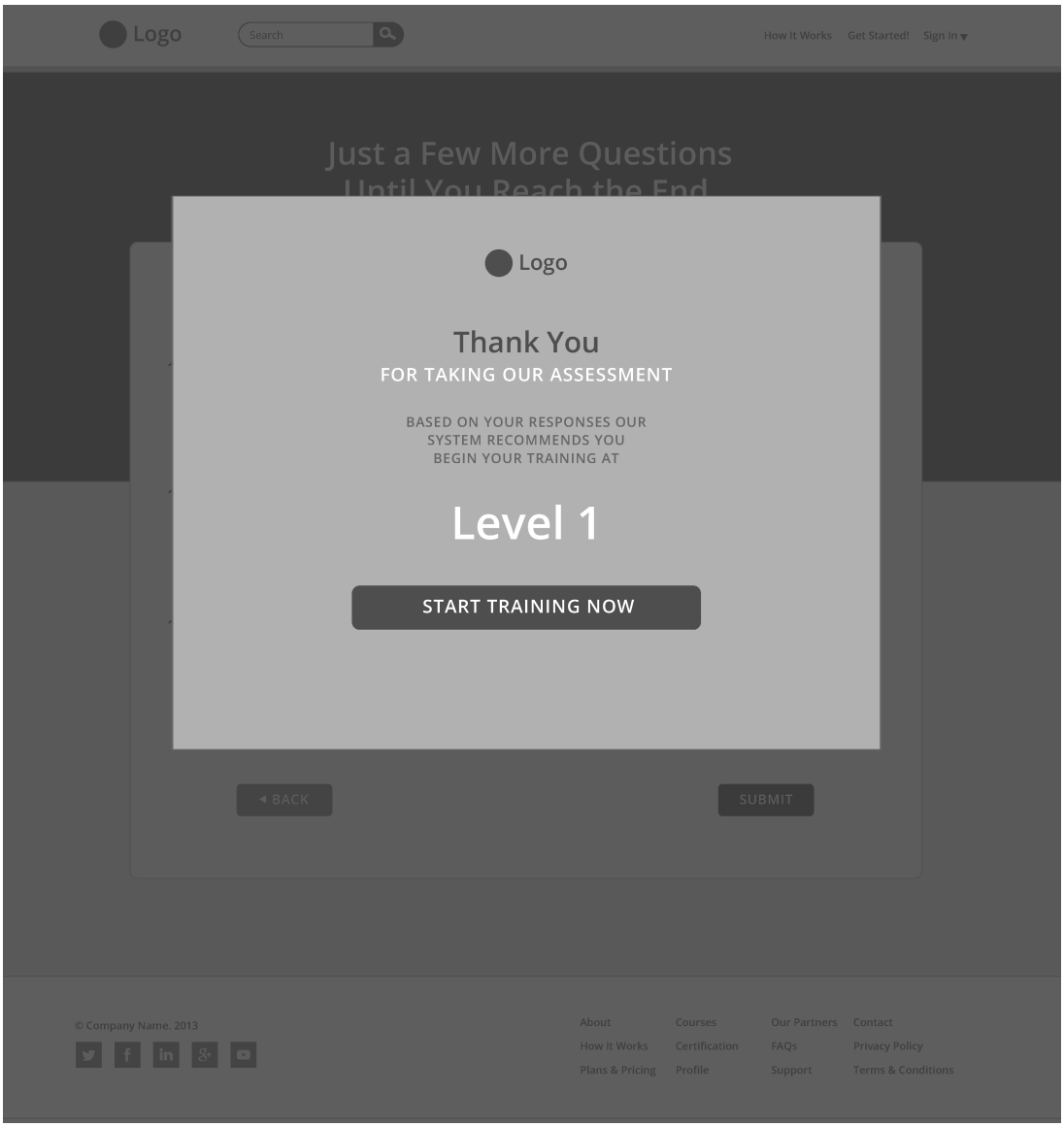


Figure 27e. Assessment Completion Modal Window.

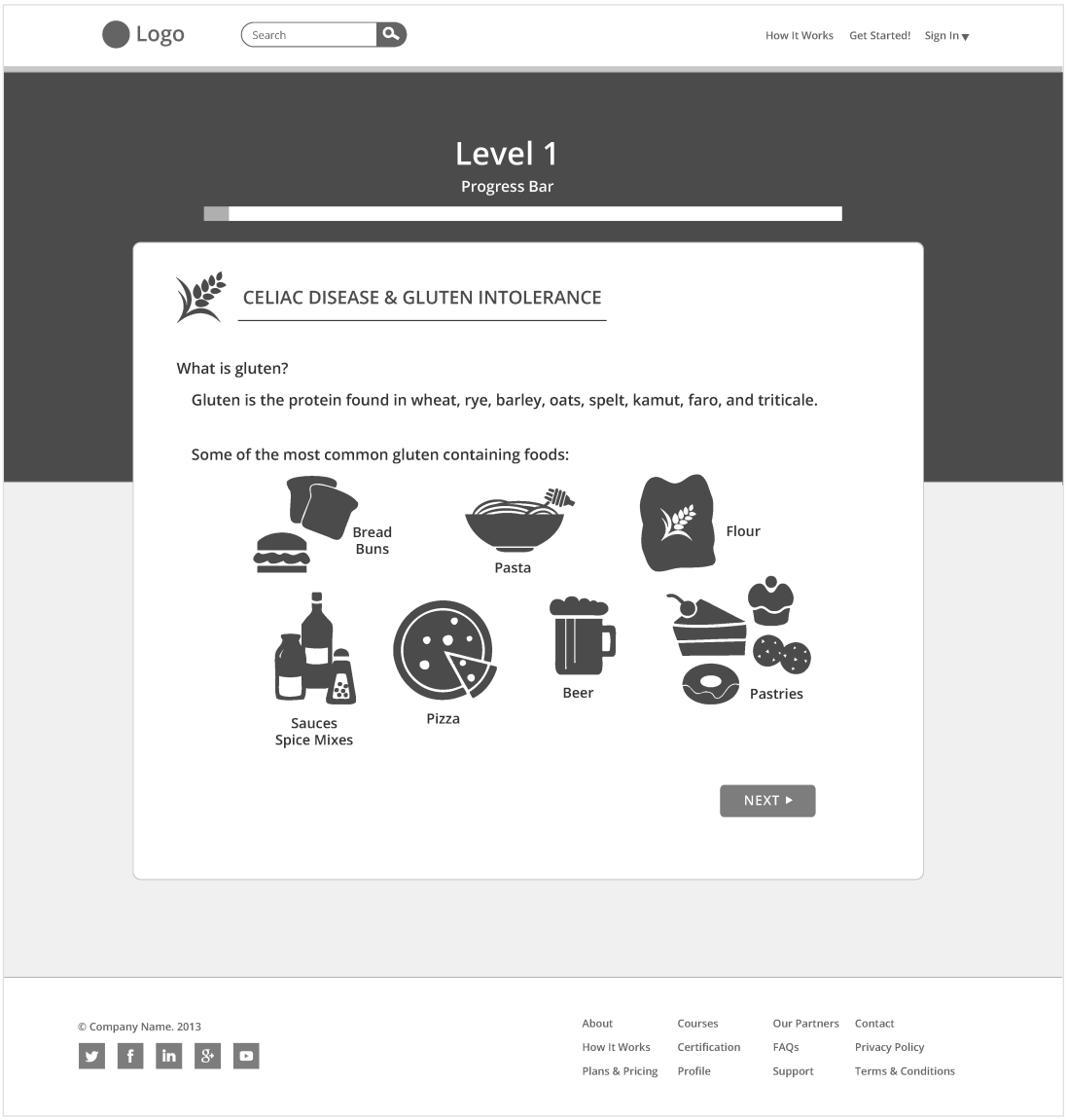


Figure 28a. First Screen of Level 1 Training: Defining Gluten, Celiac Disease, and Gluten Intolerance.

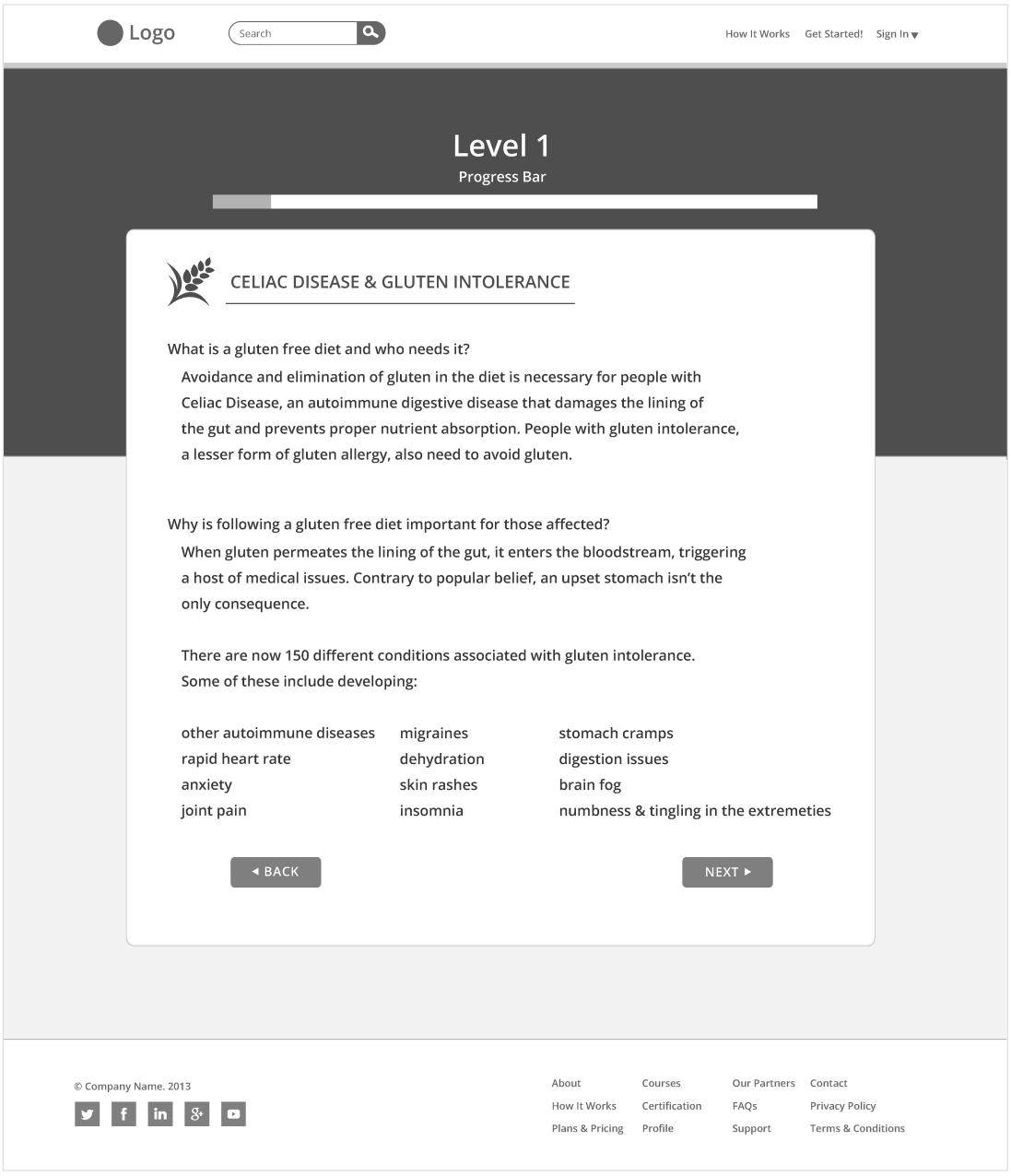


Figure 28b. Second Screen of Level 1 Training: Defining Gluten, Celiac Disease, and Gluten Intolerance.

The users then proceed through the learning screens of Level 1 training. The first two screens pertain to defining gluten and the necessity of a gluten-free diet for those with sensitivities (see Figures 28a–b). An interactive activity designed to show the effects of gluten on the human body is the next step (see Figures 29a–f). The activity uses drag

and drop mechanics, requesting the users drag the gluten-laden foods onto the diagram of the human body. This is accomplished in the paper prototype by printing the food icons and cutting them apart into separate pieces so the users can move them in the same manner as if they would in a digital version. As the foods are dropped onto the body, the side effects and reactions of gluten are witnessed. The reactions—brain fog, joint pain, rapid heart rate, autoimmune disease, and skin rashes—grow as more gluten is added to the body. This gives the users a glimpse into the serious consequences gluten cross-contamination has for the gluten intolerant. Although, this activity is not scored, the game is still valuable to the users' learning, thought process, and visceral response, and is drawn upon for their future challenges to improve their score.

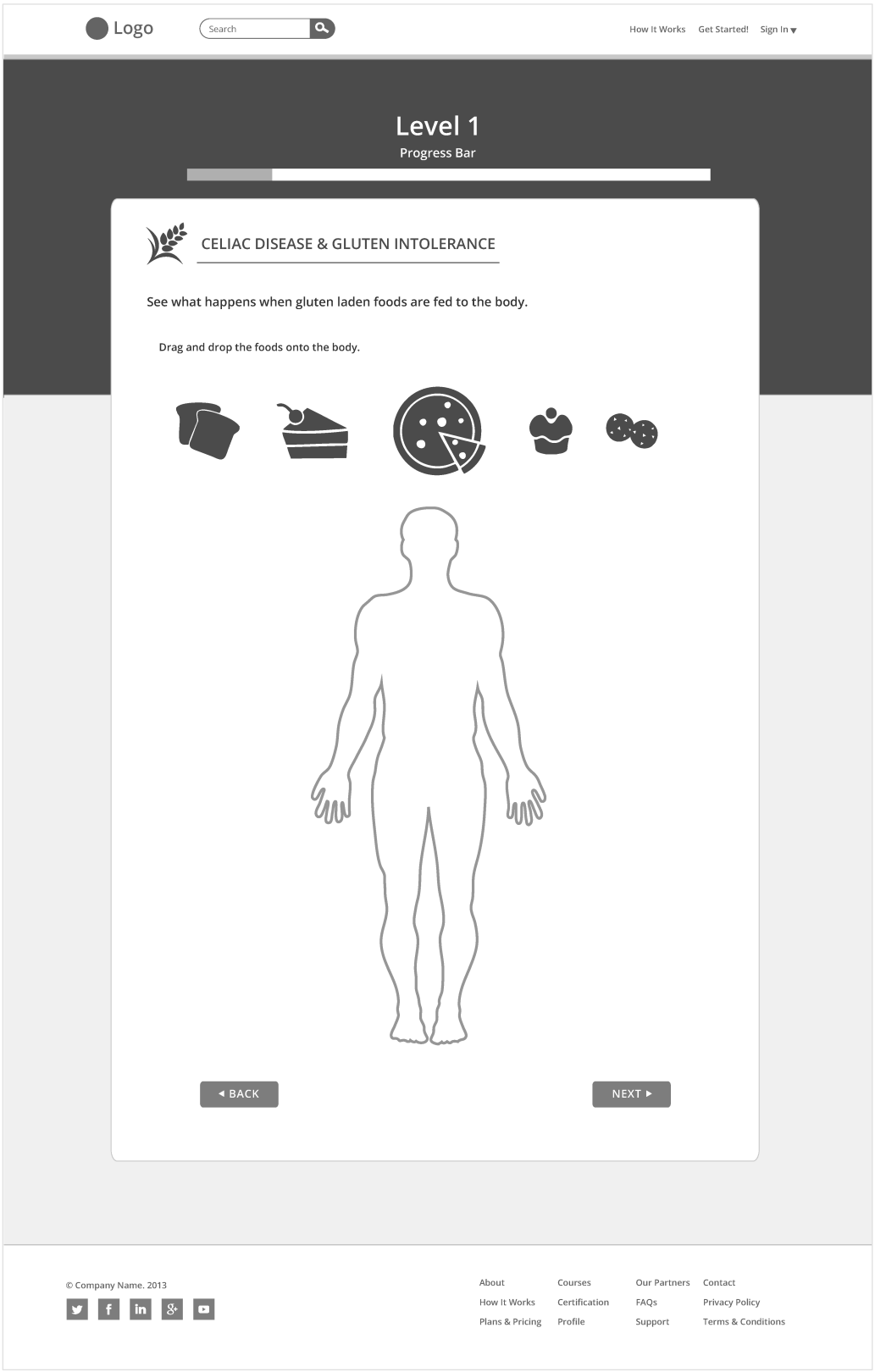


Figure 29a. Interactive Activity Showing Effects of Gluten on the Human Body.

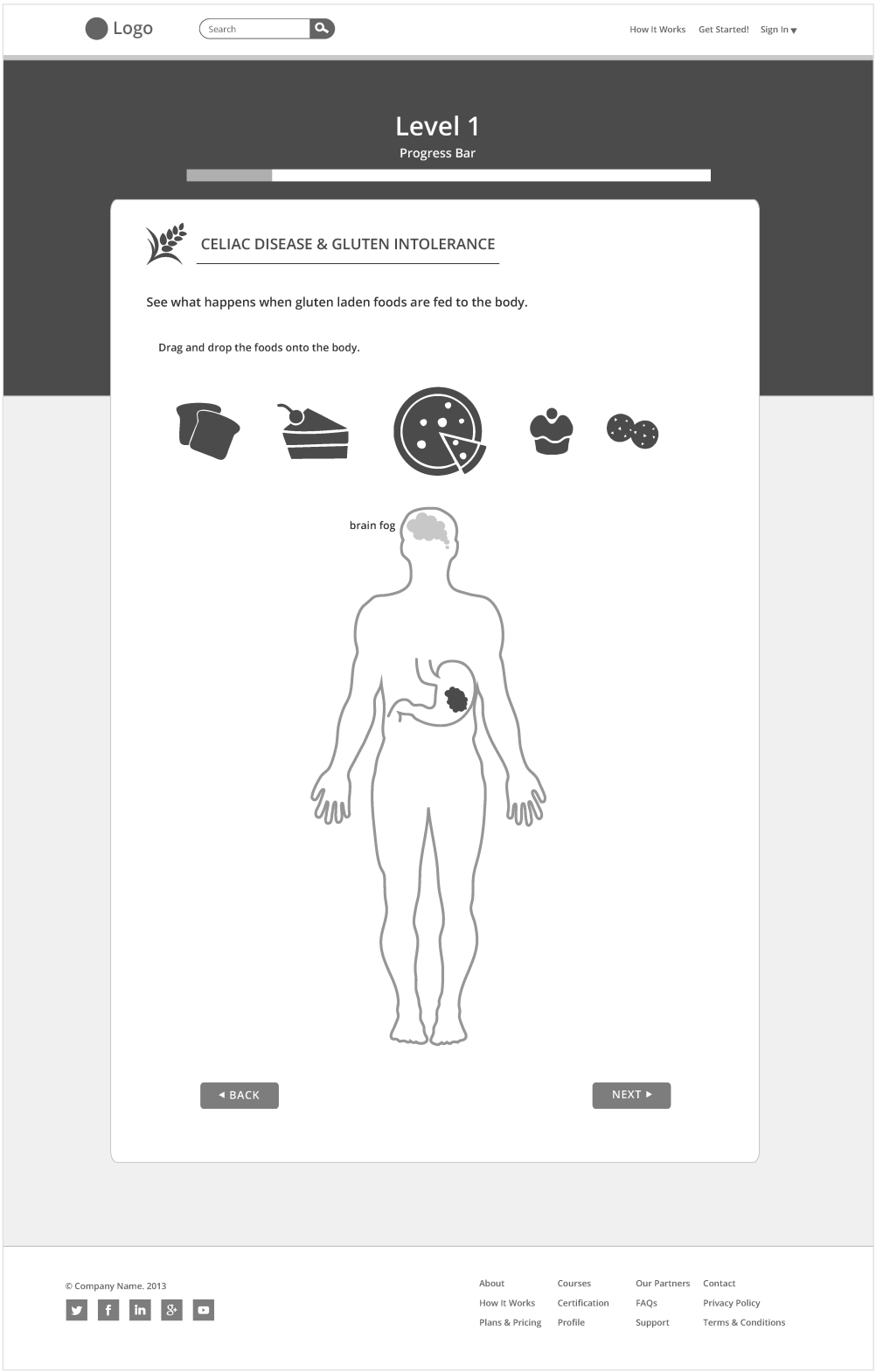


Figure 29b. Alternate Screen for Interactive Activity Showing Effects of Gluten on the Human Body.

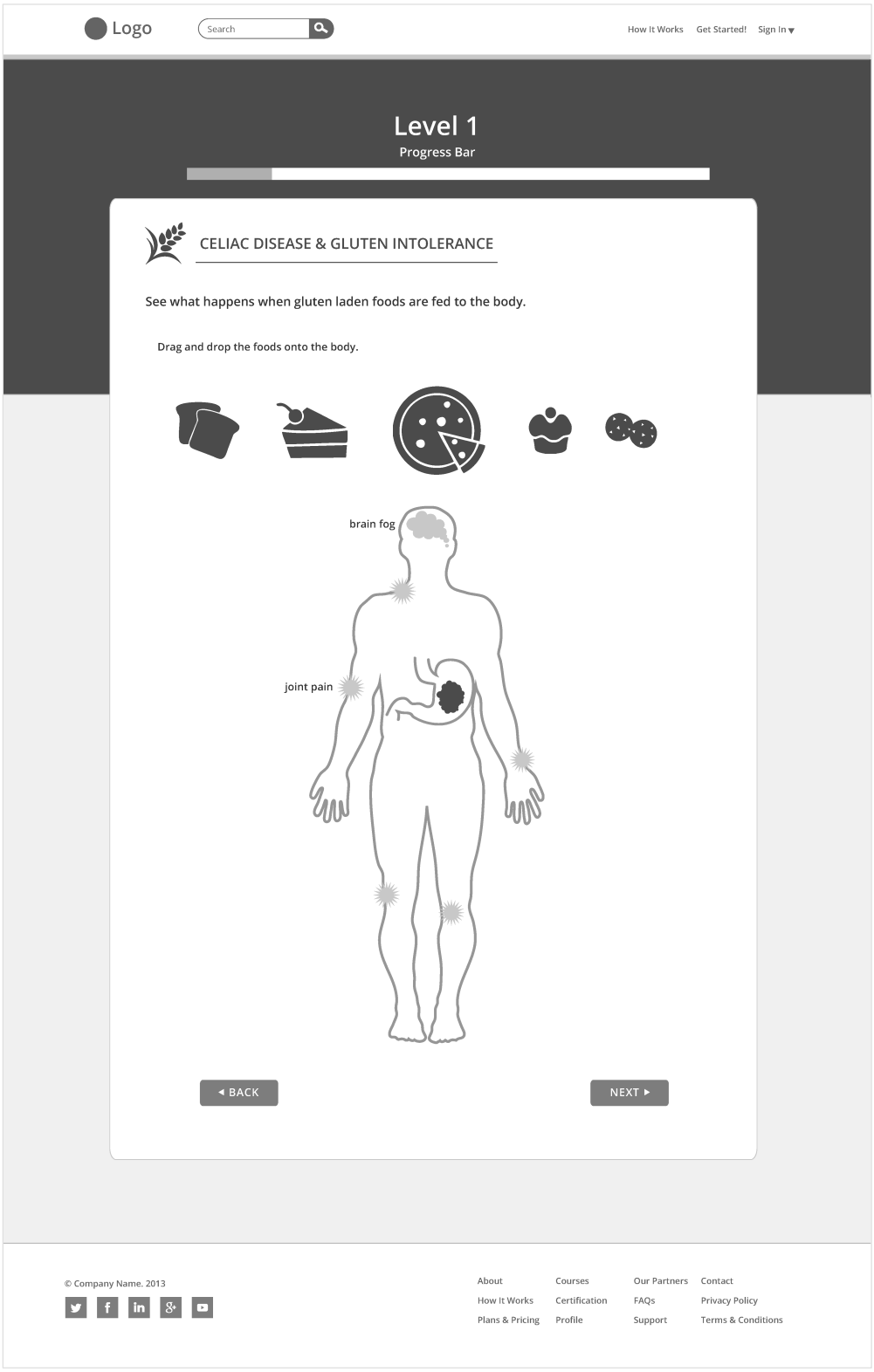


Figure 29c. Alternate Screen for Interactive Activity Showing Effects of Gluten on the Human Body.

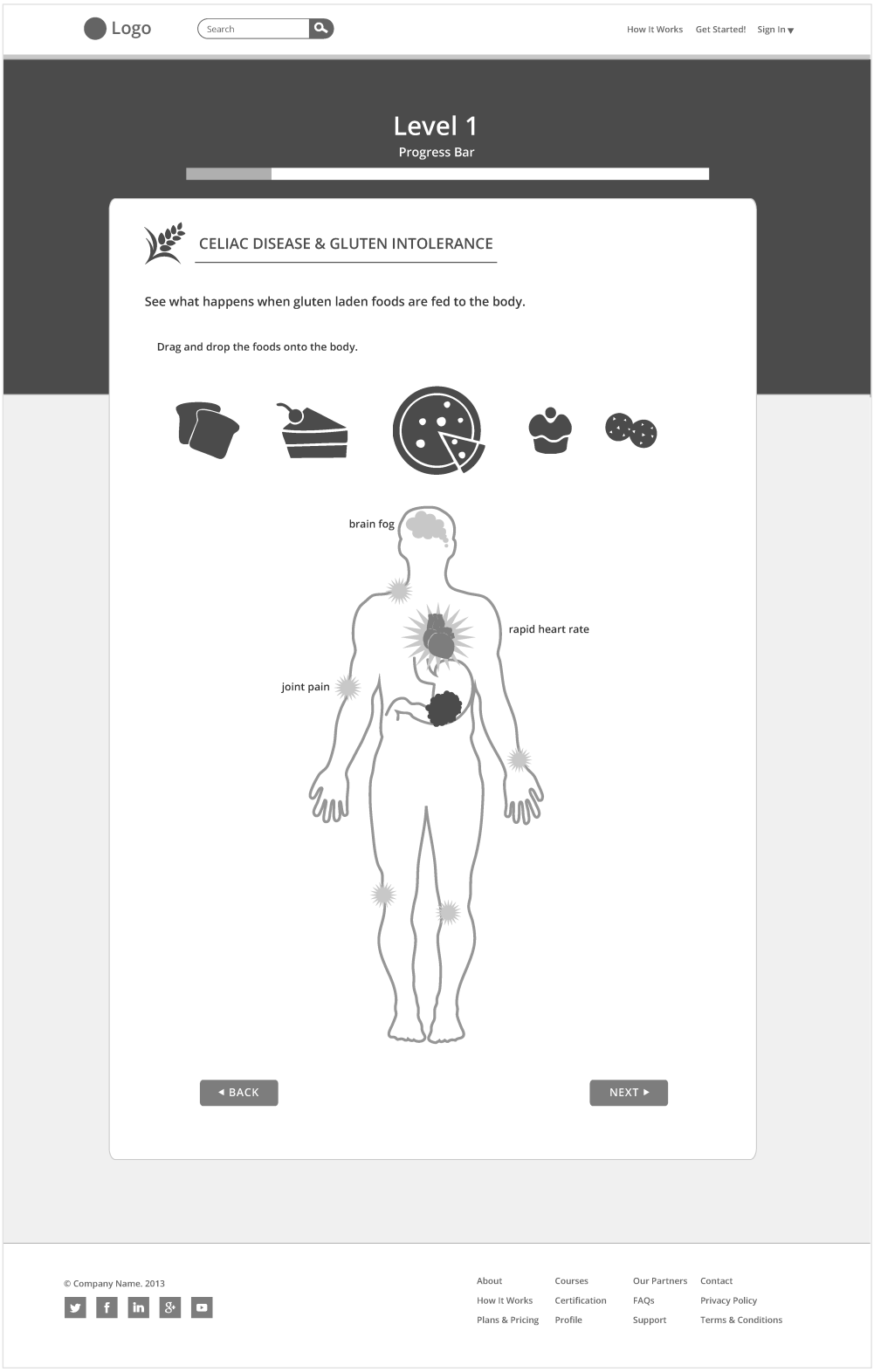


Figure 29d. Alternate Screen for Interactive Activity Showing Effects of Gluten on the Human Body.

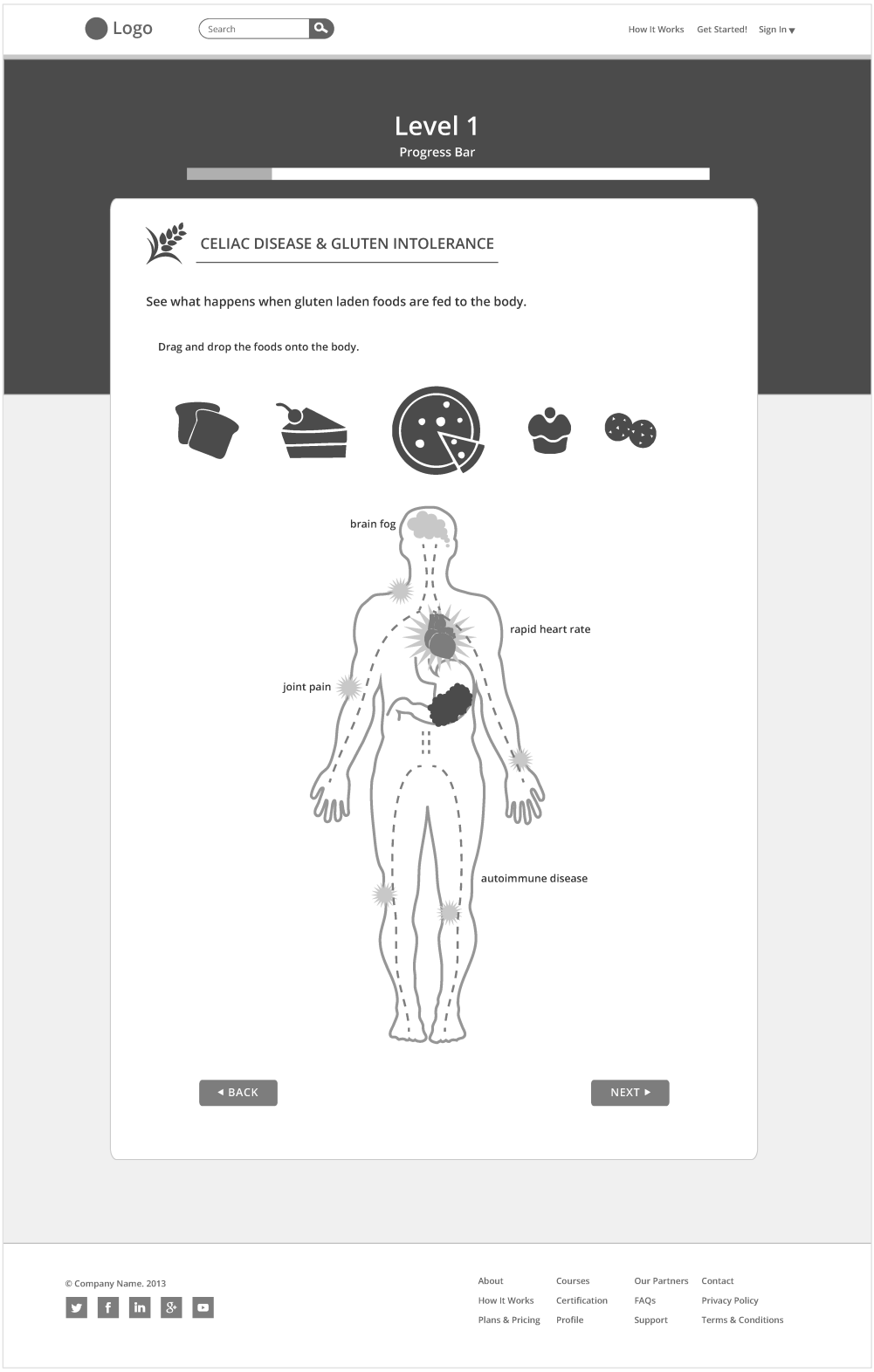


Figure 29e. Alternate Screen for Interactive Activity Showing Effects of Gluten on the Human Body.

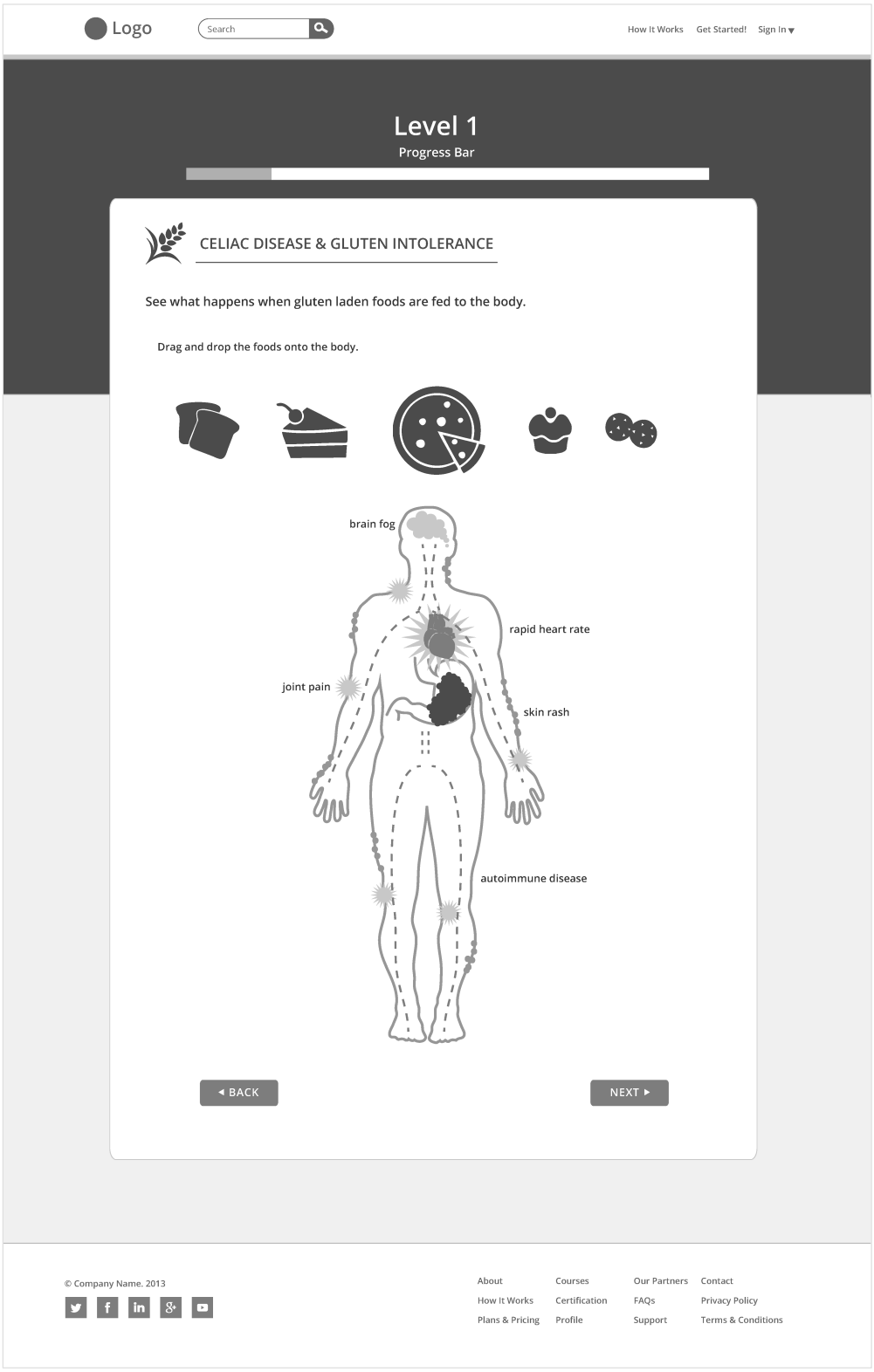


Figure 29f. Alternate Screen for Interactive Activity Showing Effects of Gluten on the Human Body.

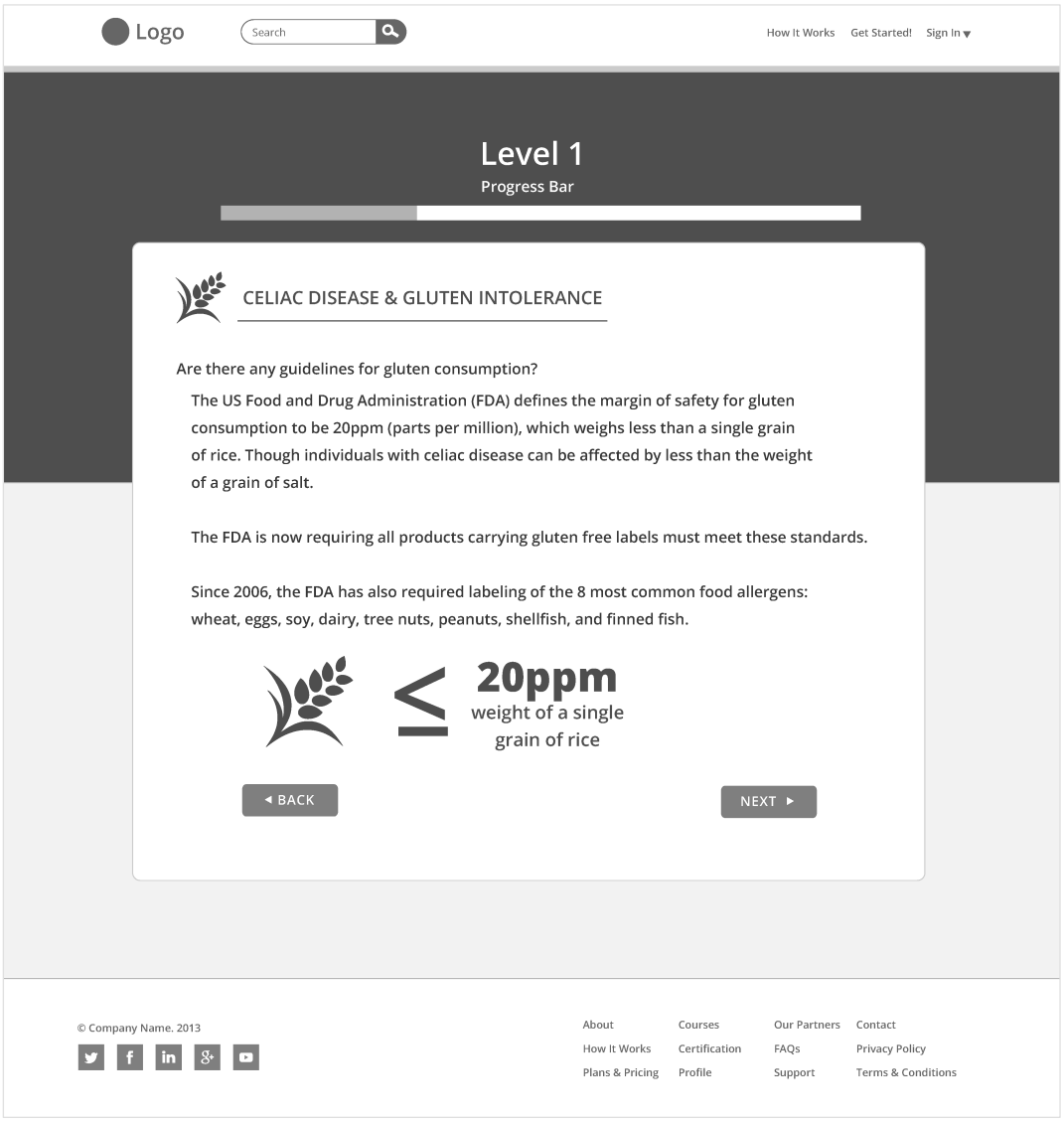


Figure 30. FDA Guidelines for Gluten Consumption.

The following screen highlights the guidelines for gluten consumption posed by the US Food and Drug Administration (see Figure 30). The users face their first timed challenge where they are required to identify and eliminate the gluten containing foods from a selection of icons (see Figure 31). In the digital interface, the users click on each of the gluten-rich foods to eliminate them, but for the paper prototype the users are asked to simply draw an "X" over the icons they choose to eliminate. The time limit for the challenge is thirty seconds with a possible score of twenty out of twenty. If the users

score eighteen or less, they are required to replay the game and to improve their score before they are allowed to continue the training.

Figure 31. Timed Challenge 1: Gluten Elimination Game.

The next section of the lesson deals with the introduction of cross-contamination and how it applies to the users' restaurant positions (see Figure 32). The procedures for cross-contamination are broken down according to the most common occurrences: cooking, food preparation, and food storage (see Figures 33a—b). Storytelling then becomes a part of the learning process as users are asked to read, analyze, and evaluate the presented situation to determine where the issues occurred and how the dilemma can be avoided in the future (see Figures 34a–34b). The second timed challenge employs the gamification technique of sorting, prompting the users to drag and drop food icons into storage columns according to whether the items are designated for gluten-free storage or for regular food storage, due to their need to be separated in a commercial kitchen (see Figure 35). The food icons are again printed and cut apart into separate pieces for the paper prototype so the users can arrange them in the correct column. The time limit and possible score is the same as in the first timed challenge, and the users are again required to replay the game until they achieve the acceptable score to continue. The final screen in the user testing prototype is a modal window informing the users they have passed the Level 1 training, with options to view the rewards they have earned or to continue onto Level 2 training (see Figure 36). The results of the paper prototype user testing will be examined in Chapter V.

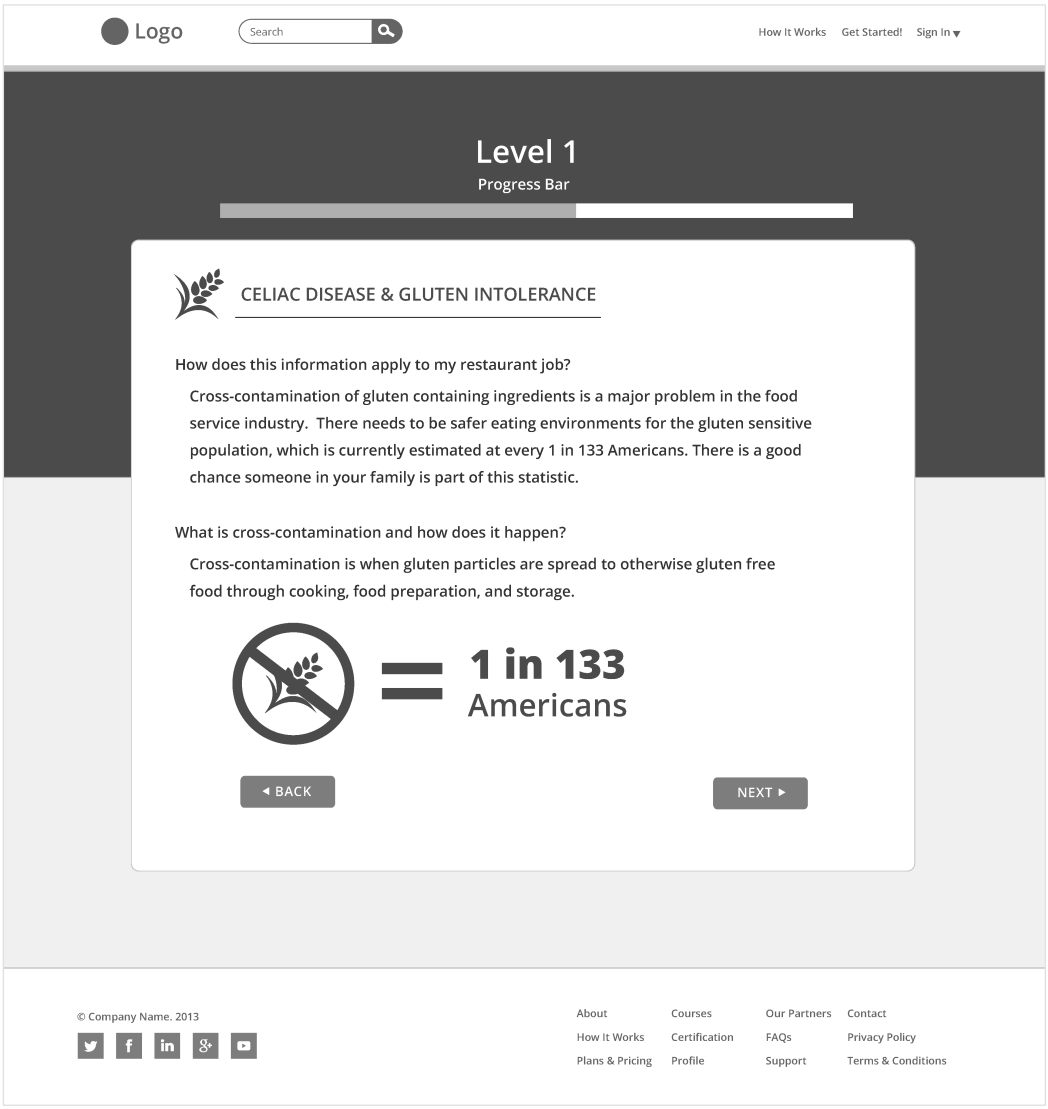


Figure 32. Introduction to Cross-Contamination Information.

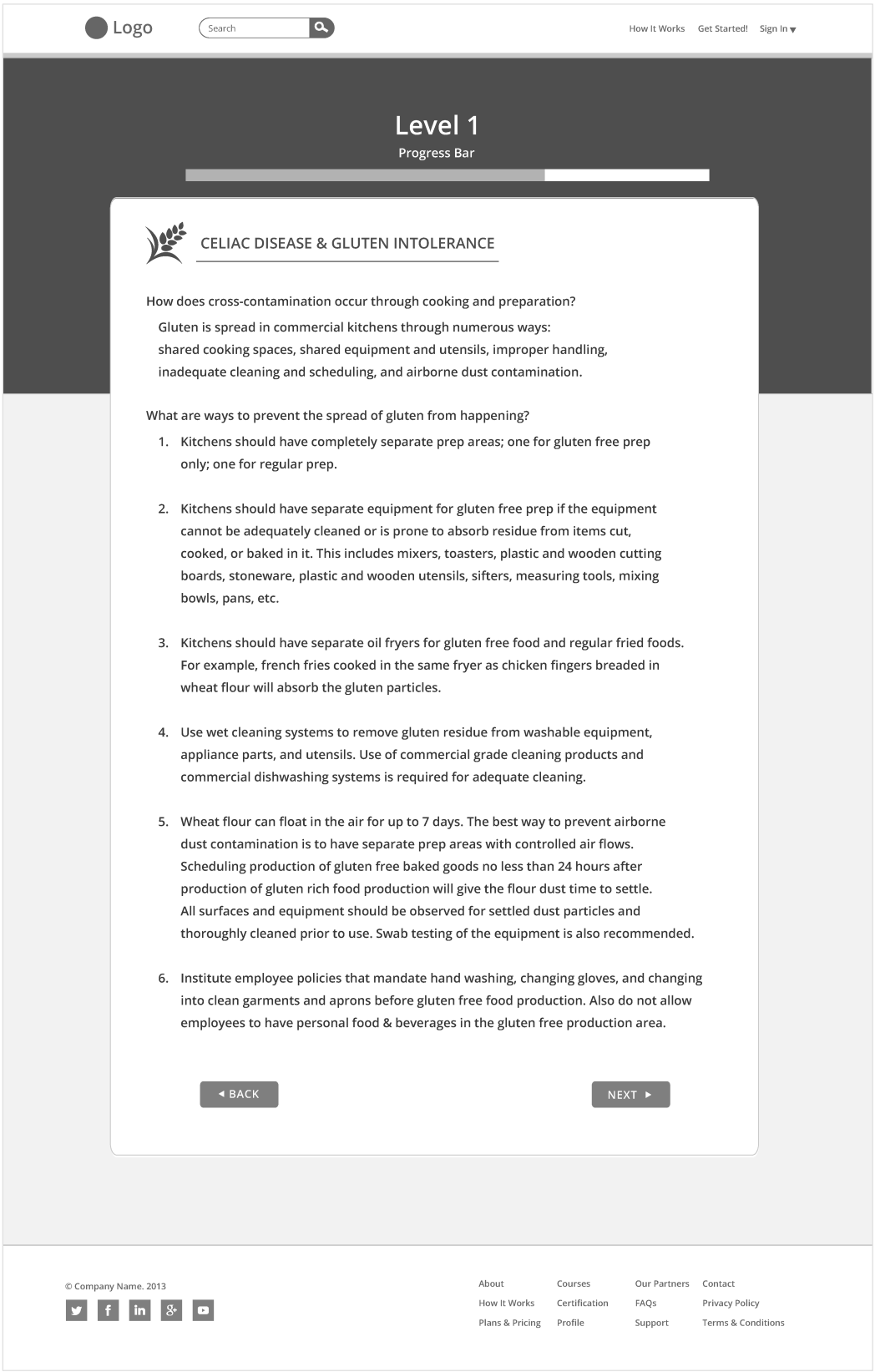


Figure 33a. How Cross-Contamination Occurs Through Cooking and Food Prep.

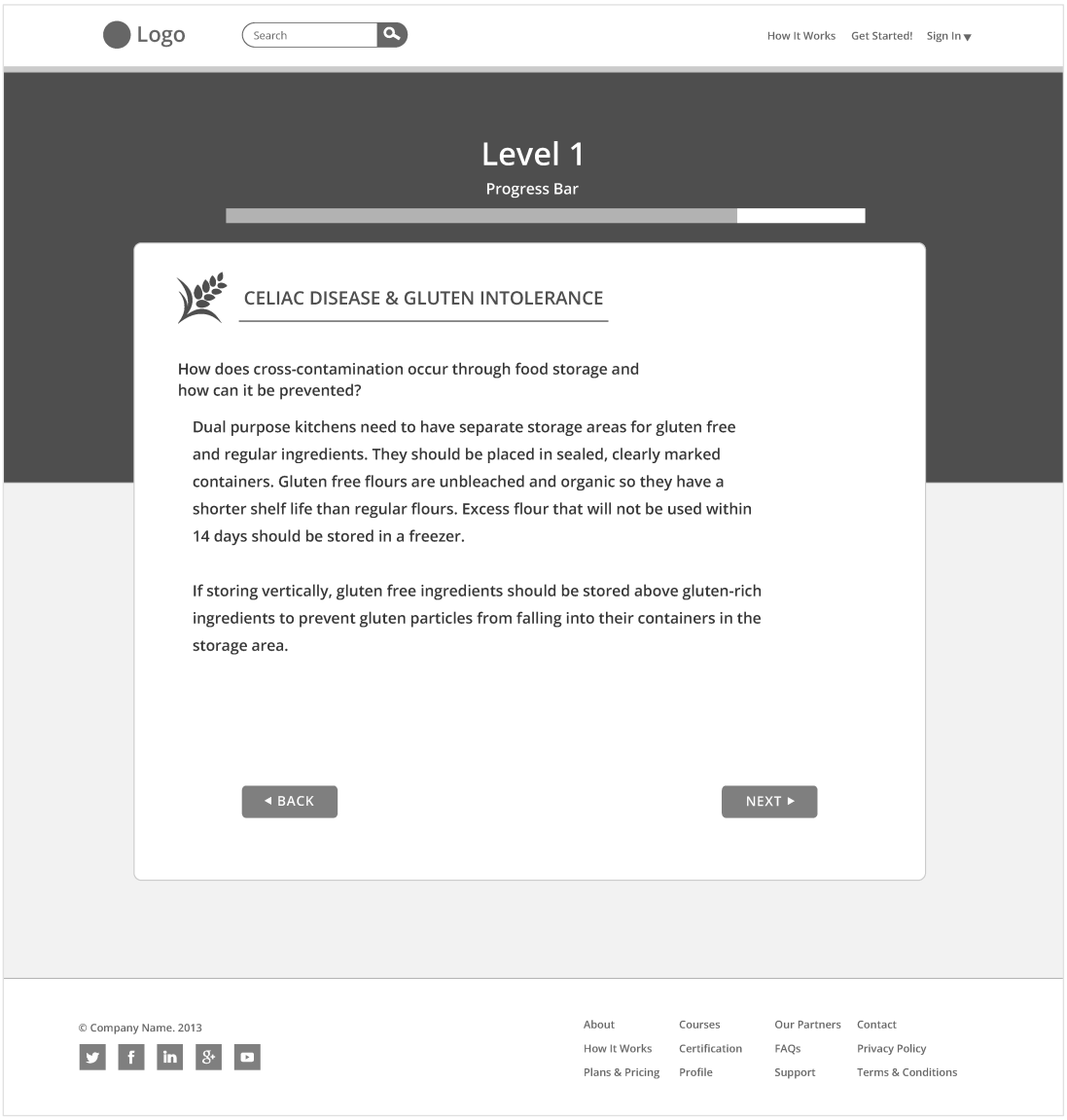


Figure 33b. How Cross-Contamination Occurs Through Food Storage.

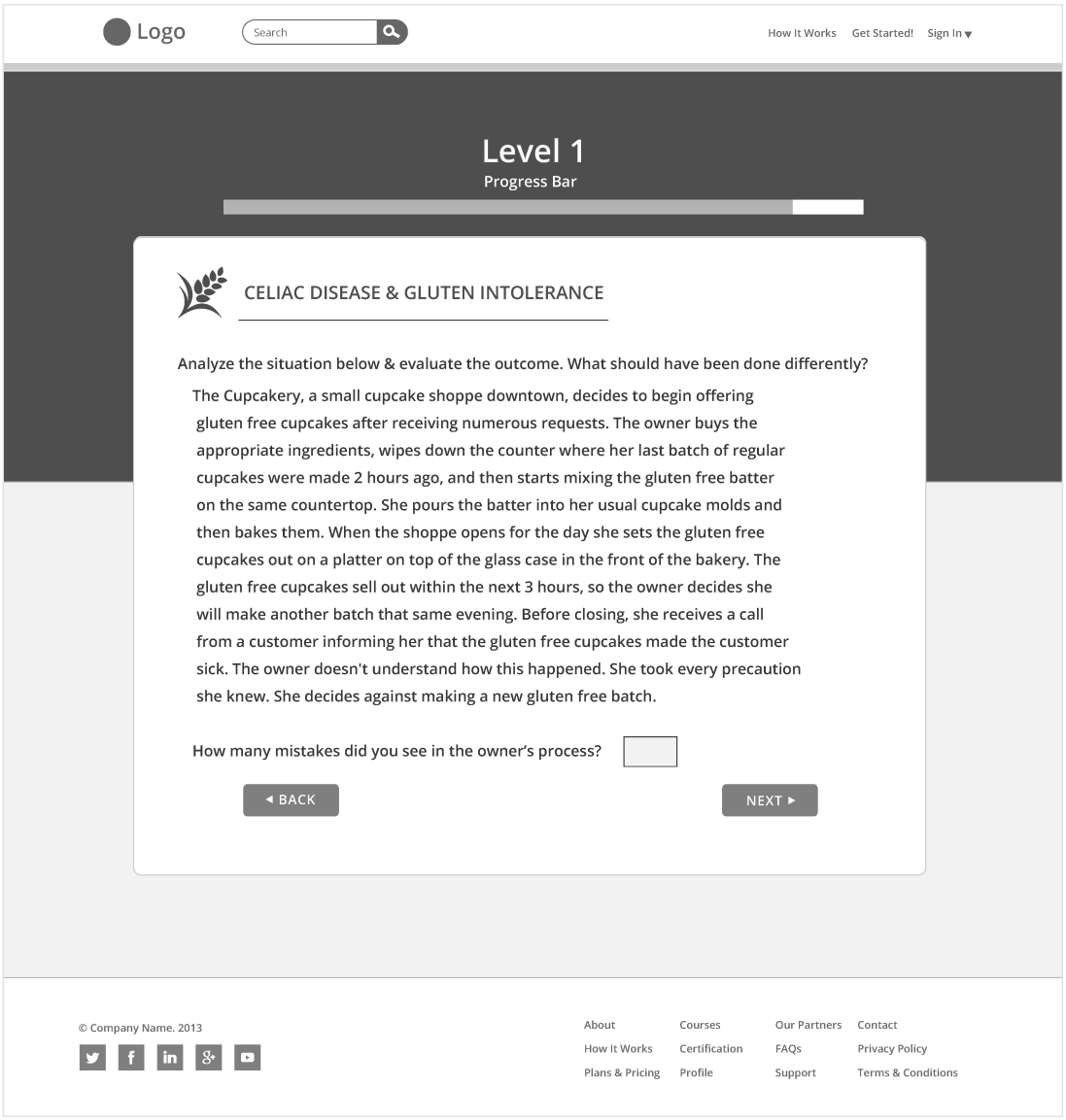


Figure 34a. Storytelling Exercise Screen 1.

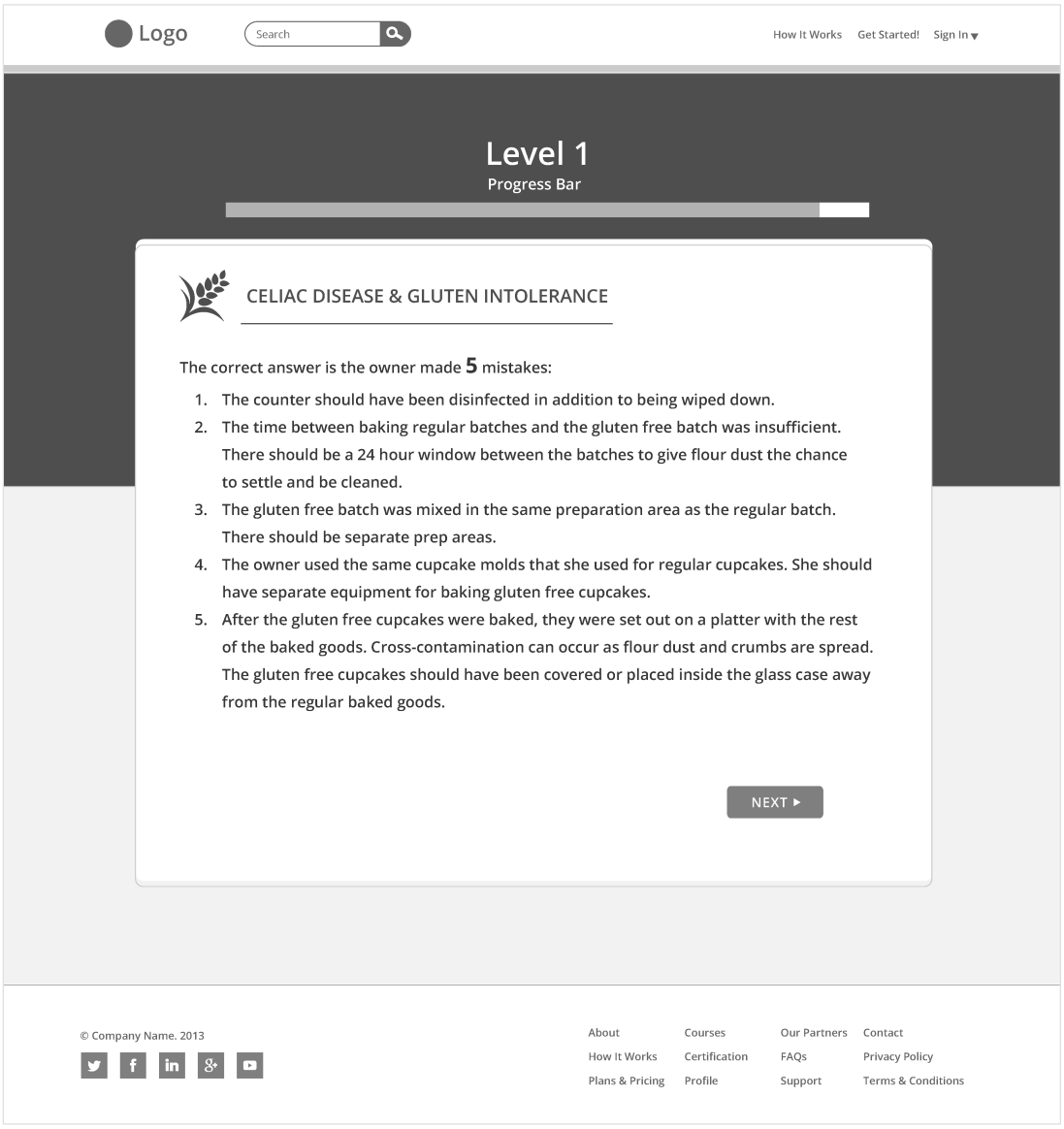


Figure 34b. Storytelling Exercise Screen 2.

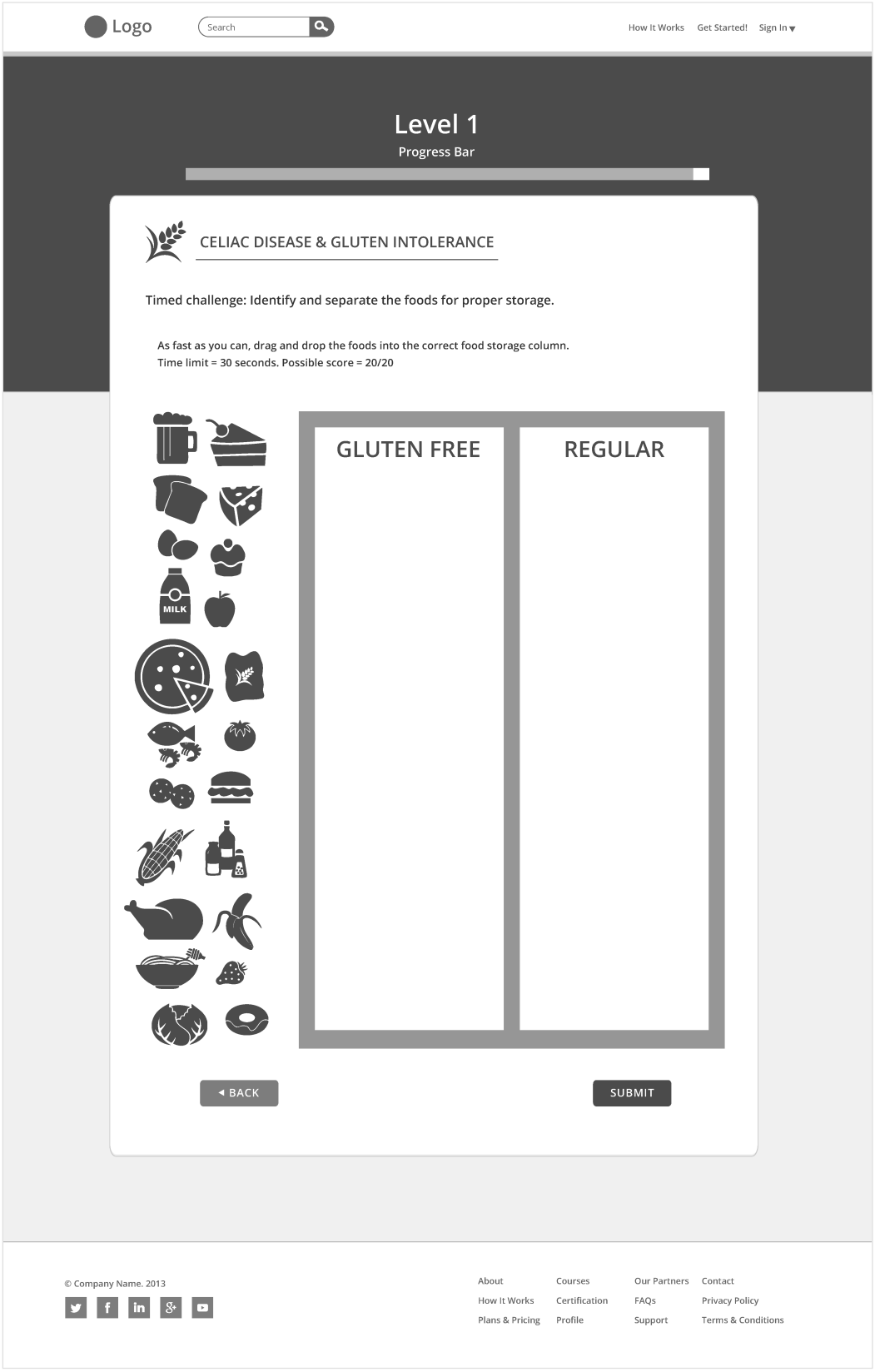


Figure 35. Timed Challenge 2: Food Storage Sorting Game.

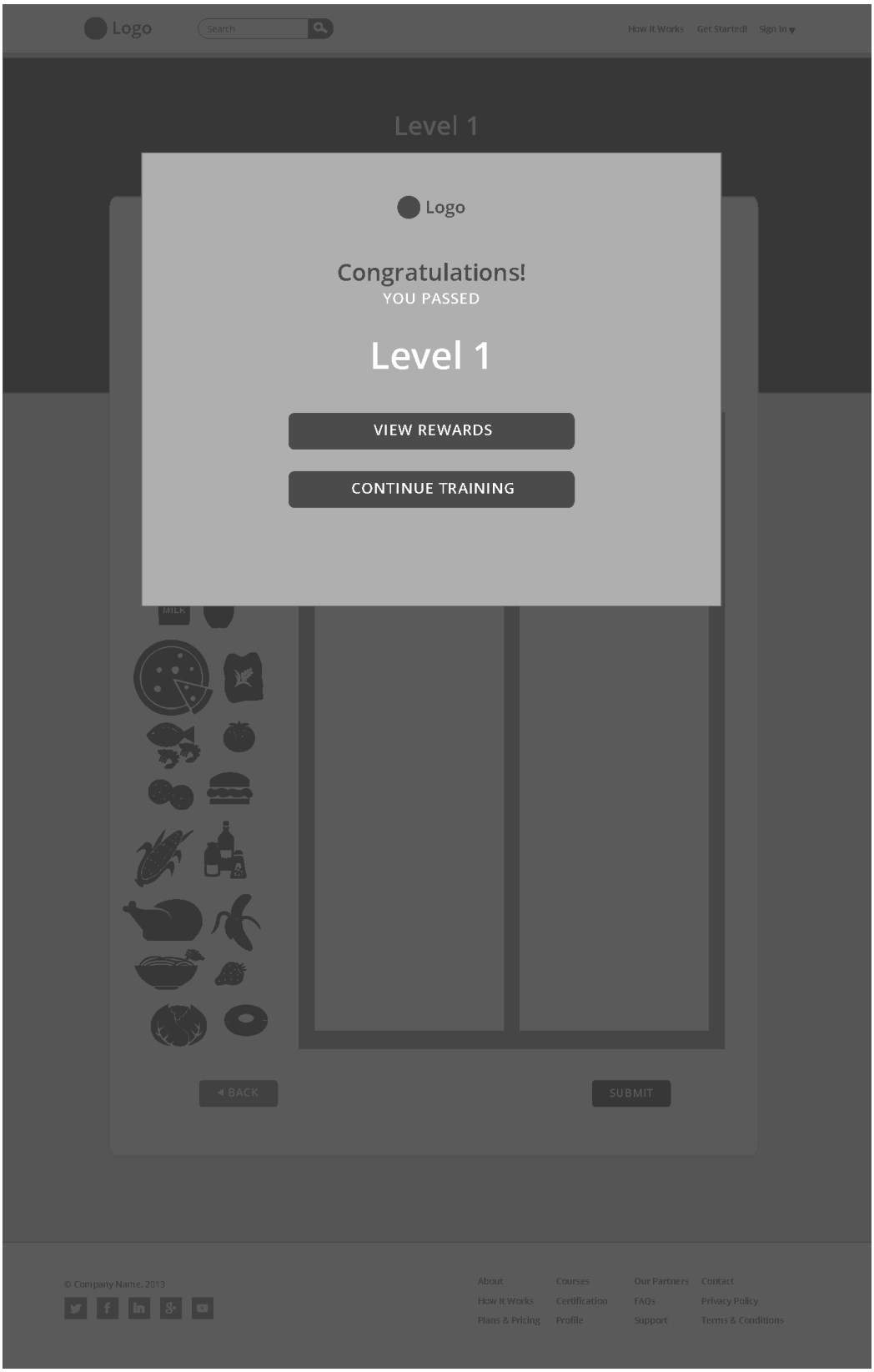


Figure 36. Level 1 Training Completion Modal Window.

CHAPTER V

Results

The paper prototype user test was administered to five participants on October 12, 2013. Most of the participants fall into the target demographic of experienced restaurant employees. The identities of the participants shall remain anonymous, so for this results analysis they are referred to as *Participants 1–5.* The sample size of the five participants in the user testing is known as an exploratory group. Martyn Denscombe (2010), a business and law professor, explains in *Good Research Guide: For Small-Scale Social Research Projects,* "An exploratory sample is used as a way of probing relatively unexplored topics and as a route to the discovery of new ideas or theories" (p. 24). Exploratory samples help researchers determine the validity of conducting large-scale studies, and are meant as a tool to expose flaws and provide insight. As the results from exploratory examples are not definitive, they are used as a foundation for further research. The purpose of the test was to assess the usability of the user interface design, and the effects of gaming and storytelling tactics on the participants' ability to understand and recall the information.

This chapter contains the participant feedback, satisfactions ratings, task completion rates, timed challenge success rates, errors, and recommendations for improvement.

Methodology

Each individual test session lasted approximately 25 minutes. During the session, the test administrator explained how the test would be conducted and asked the participants a series of questions pertaining to the frequency of their internet usage, the

types of sites they visit, and their familiarity with online learning experiences. Participants were then shown the first homepage screen of the site and asked to describe what they felt the purpose of the site was and what they would click on first. They were also asked what they were drawn to about the site and if anything about the site was off-putting to them. The participants were then given two tasks to complete—find and click the link to learn how the training works; find and click the link to begin their training session. Once they successfully, reached the assessment page, the participants were asked to complete the assessment, which was then scored. The participants were then presented with the Level 1 training material and asked to read through the screens, follow the instructions, and to complete the requested tasks. After completion of the training, the participants were given a post-test questionnaire to rate their experience.

User Testing Outcomes

Participant Pre-Test Responses

The preliminary questions revealed that 4 out of 5 (80%) of the participants use the internet everyday (see Figure 49). 80% of respondents frequently visit social media sites, 60% visit entertainment sites, 60% visit sports-related sites, and 20% responded that they frequently use the internet for work/checking email, reading news, and online shopping (see Figure 50). These preliminary questions about the participants' internet usage are valuable because they help qualify their ability to navigate a website, demonstrate the types of content the participants are interested in, and collect basic demographic information. When asked if they had ever taken a course online, 3 out of 5 (60%) of the participants responded "Yes" and 2 out 5 (40%) responded "No."

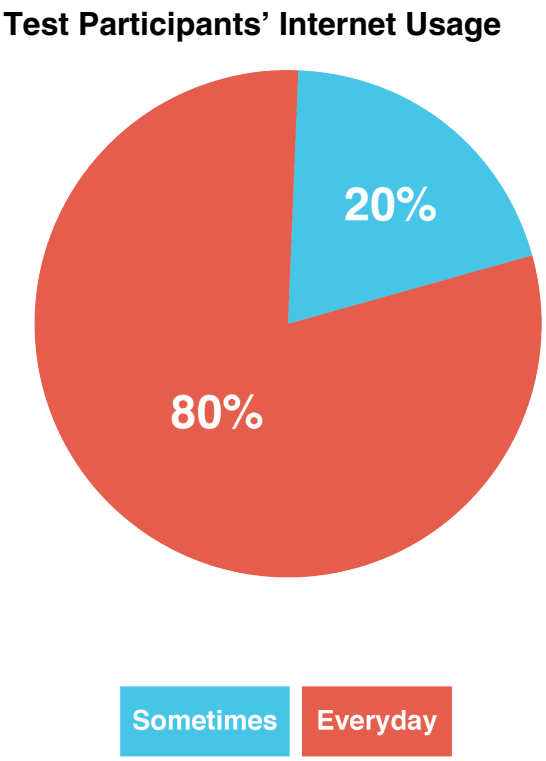


Figure 37. Test Participants' Internet Usage

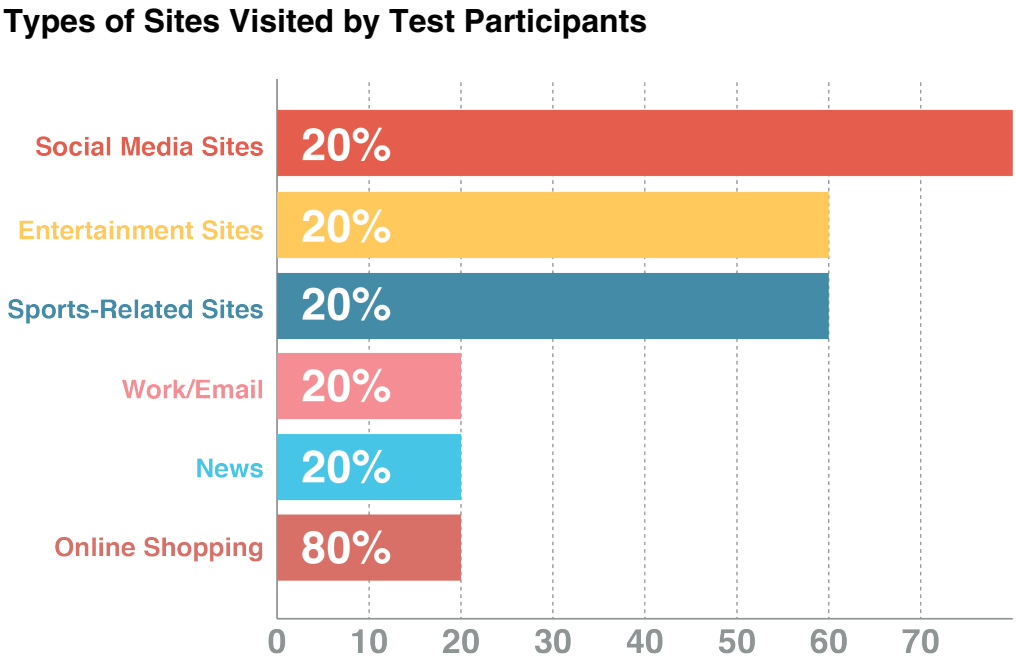


Figure 38. Types of Sites Visited by Test Participants

Task Completion Rates

The participants were asked to complete five tasks and two challenges during their test session. 3 out of 5 participants (60%) successfully completed Task 1—find and click the link to find out how the training works. Task 2, find and click the link to begin the training, was successfully completed by 4 out of 5 (80%) of the participants. All participants successfully completed Task 3 (filling out the pre-training assessment), Task 4 (the interactive activity that shows how gluten affects the human body), and Task 5 (the storytelling exercise) (see Table 5).

Table 6. Task Completion Rates

Task Completion Rates

Participant	Task 1	Task 2	Task 3	Task 4	Task 5
1	√	√	√	√	√
2	_	√	√	√	√
3	_	√	√	√	√
4	√	√	√	√	√
5	√	_	√	√	√
Success	3	4	5	5	5
Completion Rates	60%	80%	100%	100%	100%

Pre-Training Assessment Results

Task 3 required the participants to fill out the pre-training assessment to determine their prior knowledge level, experience, and attitudes towards gluten intolerance, celiac, and the need for special dietary training in restaurants. The individual responses to the assessment varied greatly (see Table 6). None of the participants were

able to correctly identify all of the food allergens associated with celiac disease and gluten intolerance. 3 out of 5 (60%) correctly identified wheat, barley, and oats. 2 out of 5 (40%) correctly identified malt. 80% (4 out of 5) missed spelt and kamut as contributing allergens, 60% (3 out of 5) incorrectly identified glucose, and 20% (1 out of 5) incorrectly identified nuts. The key to a successful gluten cross-contamination prevention plan starts first and foremost with the employees being able to correctly identify the allergens. Without this knowledge, the risk of cross-contamination becomes dangerously high, defeating the purpose of the training system.

Table 7. Pre-Training Assessment Results

Pre-Training Assessment Results

Assessment Question	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Celiac disease is a serious condition caused by food allergens	80%	20%		
Gluten intolerance is a serious condition caused by food allergens	80%	20%		
Celiac is a rare condition and doesn't affect enough people to require special dietary training		20%		80%
Gluten intolerance is a rare condition and doesn't affect enough people to require special dietary training			20%	80%
The most serious consequence for someone with celiac is a stomach ache			40%	60%
The most serious consequence for someone with gluten intolerance is a stomach ache		20%	20%	60%
Not offering bread to celiac and gluten intolerant customers is enough to keep them safe	20%		20%	60%
Offering a separate gluten-free menu is too much of a hassle			60%	40%
Accidents happen in the kitchen. There's no way to guarantee no cross-contamination		80%		20%
Celiac and gluten intolerant diners should only eat at dedicated gluten-free restaurants		20%	40%	40%

Most desired responses

When asked if they have or know someone with celiac disease or gluten intolerance, 100% of the participants replied "Yes." All participants also responded "No" when asked if they had received any training about special diets for celiac disease or gluten intolerance customers before. This is significant because it indicates that special dietary training is not commonplace in the restaurant industry, and it also sets the participants' knowledge baseline for subsequent responses to derive from common knowledge and assumptions rather than facts.

Most of the participants (80%) strongly agreed that both celiac disease and gluten intolerance are serious conditions caused by food allergens. 4 out of 5 (80%) of the participants strongly disagreed that celiac disease and gluten intolerance are rare conditions and do not affect enough people to require special dietary training. These findings demonstrate that the majority of participants understand the seriousness of celiac and gluten intolerance, recognize that it is no longer a rare condition, and also agree that enough of the population is affected that special dietary training is warranted.

3 out of 5 (60%) participants strongly disagreed that a stomachache is the most serious consequence for someone with celiac disease or gluten intolerance. The same percentage (60%) also disagreed that not offering bread to celiacs or gluten intolerant diners is enough to keep them safe. 40% of participants strongly disagreed and 60% somewhat disagreed that offering a gluten-free menu is too much of a hassle for restaurants. It is clear from these results that the participants are aware that other steps besides refraining from offering the customer bread need to be taken to ensure the gluten sensitive can dine without worry of allergen contamination.

The majority (80%) of the participants somewhat agreed that there is no way to prevent cross-contamination from occurring because accidents happen in the kitchen. However, only 20% somewhat agreed that celiac and gluten intolerant diners should only eat at dedicated gluten-free restaurants; there was a split between the remaining participants with 40% strongly disagreeing and 40% somewhat disagreeing. Analysis of these results indicates that most of the participants are unknowledgeable of cross-contamination prevention protocols and because of this they are under the assumption that the gluten intolerant have to dine at their own risk.

The purpose of the pre-training assessment is for the system to gauge the level at which the users should begin their training. *Participant 1* scored 85% overall; *Participant 2* scored 80% overall; *Participant 3* scored 60% overall; *Participant 4* scored 82% overall; and *Participant 5* scored 75% overall. Based on their responses and their inability to correctly identify all of the food allergens from Question 1, all five participants were recommended their training begin at Level 1.

Timed Challenge Success Rates

The participants were asked to complete two timed challenges during the Level 1 training session. The first challenge was the Gluten Elimination game where the users are required to correctly identify and eliminate the gluten-containing foods. If the participants scored 18 or less out of 20, they were required to retake the test until scoring at least 19. There is a high bar set for the scoring challenges due to the seriousness of the consequences that can result from errors made by the employees when serving gluten sensitive customers. Only 1 out of 5 (20%) participants needed to retake the challenge. The final results showed: 2 out of 5 (40%) participants received a perfect score on this

first challenge; another 40% scored 95%; and the remaining 20% of participants scored 90% (see Table 7).

Table 8. Timed Challenge 1 Success Rates

Timed Challenge 1 Success Rates

Participant	1st score	Retake?	2nd score	2nd Retake?	3rd score
1	20/20	N			
2	20/20	N			
3	18/20	Y	20/20	N	
4	19/20	N			
5	19/20	N			

The second timed challenge was a Food Storage sorting game where users are asked to identify and arrange the food items shown into the proper food storage columns based on their gluten content. Only 1 out of 5 (20%) participants received a perfect score the first time taking the challenge; 2 out of 5 (40%) received 95%; and 2 out of 5 (40%) of participants were required to retake the challenge. After retaking the challenge, 1 participant passed with 100%, while the other participant scored 85% and took the challenge a third time before receiving a passing 95% score. (see Table 8). The participants that were required to retake the challenge showed confusion over the task instructions, and actually performed the task backwards—placing the gluten foods in the gluten-free column citing the reasoning that those were items that they felt restaurants should offer as gluten-free options. The time limit of 30 seconds was also a factor in the success rates of this timed challenge.

Table 9. Timed Challenge 2 Success Rates

Timed Challenge 2 Success Rates

Participant	1st score	Retake?	2nd score	2nd Retake?	3rd score
1	20/20	N			
2	19/20	N			
3	0/20	Y	17/20	Y	19/20
4	0/20	Y	20/20	N	
5	19/20	N			

Post-Test Questionnaire Responses

After completion of the Level 1 training session, the participants were given a post-test questionnaire rating their overall impressions with the site and the site content (see Table 9). All participants strongly agreed that the information presented is useful and also agreed (60% strongly agreed; 40% somewhat agreed) that they can see the information being implemented into their daily routines.

When asked if they enjoyed playing the games and challenges, 100% of the participants strongly agreed, while 60% strongly agreed and 40% somewhat agreed that they felt challenged by the material.

The majority (80%) of participants strongly agreed the on-screen instructions and prompts were helpful, and 60% strongly agreed that the information was well organized and easy to navigate. Most of the participants (80%) also strongly agreed that the methods of presenting the material through games and interactions were helpful.

Next, the participants were asked how knowledgeable they felt after the training. 4 out of 5 participants (80%) strongly agreed that they felt more knowledgeable about

gluten intolerance and celiac disease, about gluten-free diets, and about gluten cross-contamination.

Table 10. Post-Test Questionnaire Results

Post-Test Questionnaire Results

Questionnaire Prompt	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
The information presented is useful	100%			
I can see the information being implemented into my daily routine	60%	40%		
I enjoyed playing the games and challenges	100%			
I felt challenged by the material	40%	60%		
The on-screen instructions and prompts are helpful	80%	20%		
The information is well organized and easy to navigate	60%	40%		
The methods of presenting the material through games and interactions are helpful	80%	20%		
I feel more knowledgeable about gluten intolerance and celiac disease	80%	20%		
I feel more knowledgeable about gluten-free diets	80%	20%		
I feel more knowledgeable about cross-contamination	80%	20%		

Participant Feedback and Suggestions

The participants were welcomed to offer any feedback and suggestions pertaining to their testing experience, the site content, or the overall site design. Some of the most

common feedback was positive reactions to the use of icons and visual representations of what is stated in the content. *Test participant 3* insightfully remarked that it is a clever idea to cater to different learning styles since some people learn verbally through reading, but others need visual stimuli to learn. The participants also liked the fact that statistics were humanized (i.e. 20ppm of gluten equals less than a single grain of rice) and gave them a basis for comparison instead of just numbers.

Positive feedback was given for the inclusion of a progress bar throughout the training. The participants like being able to tell how far they have progressed versus how much further they still have to go until the end of the training level. The overall simplicity and legibility of the site was praised, as well as the training steps breakdown on the homepage. The participants were drawn to the use of the icons and liked the fact that they could grasp a quick overview of the steps with just a quick glance.

The gaming and storytelling tactics were also positively received, and the participants felt that it was helpful to be presented with the correct answers at the end of the storytelling exercise. When the test administrator inquired whether the storytelling made the information more memorable, the responses were positive from all participants. The participants relayed they felt empathy for both the customer that became contaminated and for the bakery owner that assumed she was taking every precaution. The story made it clear how easy cross-contamination can occur. *Test participant 1* commented that the storytelling allowed for the whole scenario to be analyzed, which presented a wider picture of the impact created by the actions of the bakery owner in the story, and by extension the impact of improper training in real life restaurant situations. The interactive body activity was acclaimed for its ability to convey the seriousness of

the reactions that occur from gluten through playful illustrations and the drag and drop interaction.

There were a few suggestions made by the participants on ways to improve the experience. Upon rollover, providing a callout or link to more information about the food allergens presented in the beginning of the training level was one suggestion. Offering the ability for the site to read the information aloud to the users was commented. Adding a references or resources page was also mentioned. The suggestion was made to add a neutral or not applicable option to the pre-training assessment responses for instances that the users do not have any experience pertaining to the question being asked.

Potential Site Improvements

Based on the task success results, the links on the homepage corresponding to learning how the training works and to beginning the assessment should be given more emphasis and/or explanation to get the users to click on the correct links. This means raising their importance in the design hierarchy. The section of the training about how cross-contamination occurs through cooking and food preparation could be further broken down into subsequent screens to limit the amount of onscreen text being read at one time. Consideration should be made for increasing the time limit to at least 45 seconds for the second timed challenge, allowing more time for the participants to finish the task. The food storage sorting game also needs to be clarified, as there was some confusion amongst 2 of the 5 participants that hindered their ability to pass the challenge on the first try. This improvement may be providing further instructions or rewording the instructions to make the task more clear.

Overall Results

The majority of the participants found the training site to be well-organized, clean and uncluttered, useful, easy to use, fun, and challenging. There were also overall positive responses to the interactive gaming activities and storytelling elements. Even though the storytelling exercise was completed by 100% of the participants, only 1 out of 5 (20%) answered the question about the story correctly when asked how many mistakes the owner made in her process when making gluten-free cupcakes. Most of the participants correctly identified the majority of the mistakes, however they also overlooked at least one or more. The participants felt more knowledgeable after the training was completed, and they were also able to recall the information taught when facing the timed challenges.

CHAPTER VI

Conclusion

This research is intended to determine if using cognitive psychology as a basis for user experience and user interface design improves the effectiveness of food allergen safety training for employees in the restaurant industry. The ultimate goal was to create safer eating environments for the growing percentage of the population with celiac disease or gluten intolerance, through the reduction or elimination of gluten cross-contamination occurring in commercial kitchens as a result of improper education and insufficient procedural knowledge. The project posed a solution through the use of task-based training, interactivity, storytelling and gaming elements designed to actively engage the users and increase their ability to recall the training material.

Limitations of Research

There were some limitations that appeared during the execution of this research. During the observation stage of the research, it was impractical for physical research to be conducted within commercial kitchens due to health code regulations. The information gathered was retrieved through observations made in the front-of-house and common areas of the restaurants, and through interviews with staff. In order to fully assess the kitchen situations and design the most applicable interface, further research needs to be conducted with access to the restricted areas.

Expanding the user-testing sample to a larger group of participants will provide more conclusive and definitive results. Though the exploratory user testing results indicated the application of interactive activities, gamification, storytelling, and cognitive psychology had positive effects on the users' learning experiences and ability to recall the

training material the results of this study are inconclusive as it pertains to a definitive solution.

Future Investigations

For this training system design solution to be deemed successful or not, it is necessary to conduct further research and user test a larger sample size. The additional levels of training need to be designed, as well as the implementation of the application of color. The enactment of a certification in food allergen prevention training needs to be further investigated to determine if an existing certification can be affiliated with the system, or if the appropriate governmental channels need to be navigated in order to obtain a new official certification. Exploration of a visual identity system, including a logo and name for the system, is also necessary to bring the project to completion.

The following questions have arisen as a result of the user testing outcomes:

1. Can the application of the interface be expanded to include mobile usage?

   Mobile usage allows the users to access the training system from anywhere via mobile phone, tablet, or computer. The ability of a portable training system is valuable because of the convenience it offers the users. The training would not have to be completed at the jobsite. It could easily be administered at home or even during travel. This flexibility would allow the employees to complete the training on their own schedule and to switch devices throughout the process. Mobile usage is achievable through responsive design—using fluid grids in the construction of the website in order for it to transition seamlessly for optimal viewing on any device.

2. Can the gamification elements be taken further to include virtual simulation environments for users to perform tasks?

    Simulator environments place the user in the context of physically performing tasks in given scenarios. Including virtual simulation of cross-contamination prevention procedures and customer interactions will increase the retention of the learned knowledge and better prepare the users for when they are faced with similar circumstances in real life situations.

3. Can the implementation of sound benefit the experience?

    The introduction of sound could be beneficial to the experience in different ways. Providing an auditory element that reads the content aloud can assist visually impaired users, illiterate users, or users with learning deficiencies. Sound is also important to the implementation of virtual simulation environments where dialogue is occurring between employees or between employees and restaurant customers.

4. Can the training system be implemented on a grander scale, such as for university or hospital dining facilities, in public and private school cafeterias, or hospitality and culinary schools?

    Expanding the application of the system to larger entities such as hospitals, universities, and schools would create universal cross-contamination prevention guidelines as well as provide early exposure to this knowledge when encountered in these settings. Familiarizing people with these concepts early on further diminishes the learning curve later, instills a sense of empathy, and builds a more knowledgeable restaurant workforce.

This project has the potential to further expand the breadth of training material to cover other food allergens besides gluten, as well as for the psychological design model to become the standard in restaurant industry training.

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