Klopfer's Krazy Katering

11.127/CMS.590 Digital Game Documentation

By: MIT Students

I. Introduction

Klopfer's Krazy Katering is a digital reasoning game that uses cooking to help students enhance their understanding of ratios and proportions. The game uses catering scenarios to stimulate engagement and encourages students reason through math puzzles to meet their objectives.

II. Learning Objectives & Audience

Learning objectives

Mathematical concepts come into play in everyday life, including through managing budgets and credit cards, paying back interest on school loans, and calculating area measurements for home improvement projects. One of the concepts that can be related to everyday life is the application of ratios, proportions, and measurement conversions in recipes. Enabling students to see how math applies to their life is a powerful tool to engage students in learning and help them truly understand core math concepts. This motivates the design of Klopfer's Krazy Katering.

In taking on the role of a caterer, players must determine correct ratios and proportions for the number of people they are catering for to ensure that their dishes are cooked properly. Transferring their understanding of the relationship between numbers to the relationship between ingredients gives them a real life situation in which they can apply their knowledge. Players quickly learn that in order to cook a dish at scale, they need to multiply the original recipe by a constant scaling factor. Feedback from the game will help players understand that unequal ratios will result in changing the relationship of ingredients and therefore changing the recipe altogether, which is not an ideal outcome when you are trying to provide a reliable service to customers. Through practicing working with proportions and ratios, players not only

hone their skills in the mathematical process, but they also learn how to relate these concepts to everyday life, giving them purpose for mastering these skills.

As the levels progress, a secondary learning objective is introduced: the application of optimization and problem-solving. Taking on the role of a caterer places a certain responsibility on the player to think of their gameplay as contributing to a thriving business. Part of the player's responsibility is ensuring they are making the best decision for their catering company, be it serving the most clients, limiting the waste of their ingredient supply, or making the most profit. When faced with certain objectives and constraints, players use the information they are given in order to weigh their options and choose which makes the most sense to benefit their company. In order to come to an optimization conclusion, players practice their problem-solving skills, taking into account all that they have learned and considering the goals and needs of their catering company. The application of optimization and problem-solving is yet another concept that is often applied to real life, therefore giving players a digital space to practice relevant and important life skills.

Finally, Klopfer's Krazy Katering simulates real-world events to help players experiment with the pressures of running a business. Players may have to deal with demanding clients, a limited budget, or a limited supply of ingredients. How they choose to apply their skills to find solutions to these added pressures simulates their problem-solving process in real life. Players are able to practice and apply their solutions in a safe, digital simulation space, where the feedback they receive helps inform their later strategies and ultimately helps to hone their skills.

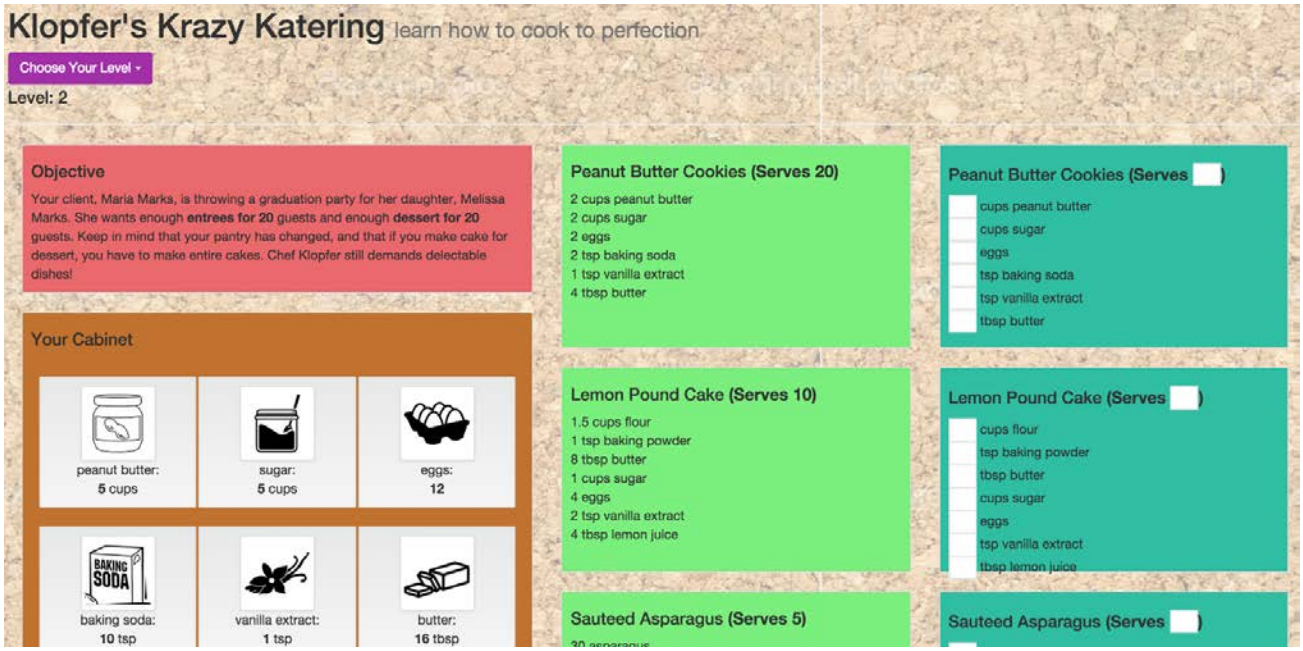
Audience

According to the common core (http://www.corestandards.org/Math/Content/RP/), ratios and proportional relationships are taught in grades 6 and 7. Although the game does not broach some of the learning principles stated in the common core (such as percentage and some mathematical terms), this game can accompany middle school students' academic work and allow them to better conceptualize these types of problems. This game could also be useful for older students who are struggling with these concepts because the digital aspect of the game allows for immediate feedback and assistance.

Given more constraints, a heightened level of difficulty, and a more developed visual design, this game could go beyond just being an academic supplement. The more difficult levels involve more optimization and problem-solving than basic proportional relationships, and these higher levels could be fun and challenging enough to a wider audience to become a marketable game.

III. Game Description

Klopfer's Krazy Katering is a single-player digital game that simulates the challenges of being in charge of a catering business. In the first few levels, the player (caterer) is given a list of needs from a client and four predetermined recipes (two entrees and two desserts) and must create dishes that are constrained by these needs and available ingredients. The player is given two entrees and two desserts in order to allow for multiple combinations of dishes to create a meal that follows the constraints. For example, the two desserts (peanut butter cookies and lemon cake) both call for butter, but the cookies call for less butter per serving. If the client asks for lots of dessert, but there is a limited amount of butter, the player would hopefully choose to prepare the cookies over the cake. The four recipes (original recipes) are accompanied by four identical recipes (new recipes) that have had their measurements replaced with input boxes. The player's goal is to decide how many servings of each dish should be prepared and to input the appropriate number amounts of ingredients in the new recipes. The player successfully completes the level once he/she has fulfilled all the client's needs (while only using the ingredients available in the *cabinet*) by putting the correct proportions into each new recipe. In a later level, the player is given two client requests and must choose which request to fulfill in order to maximize the profit, while still maintaining correct proportions of ingredients in the recipe that he/she ultimately chooses to make.



The levels increase in complexity, with the original levels having few constraints while in later levels, clients make more difficult requests and the cabinet becomes more constraining. Multiple consecutive levels use the same recipes and ingredients (but not necessarily the same amounts) in order to provide consistency to accompany the increase in difficulty.

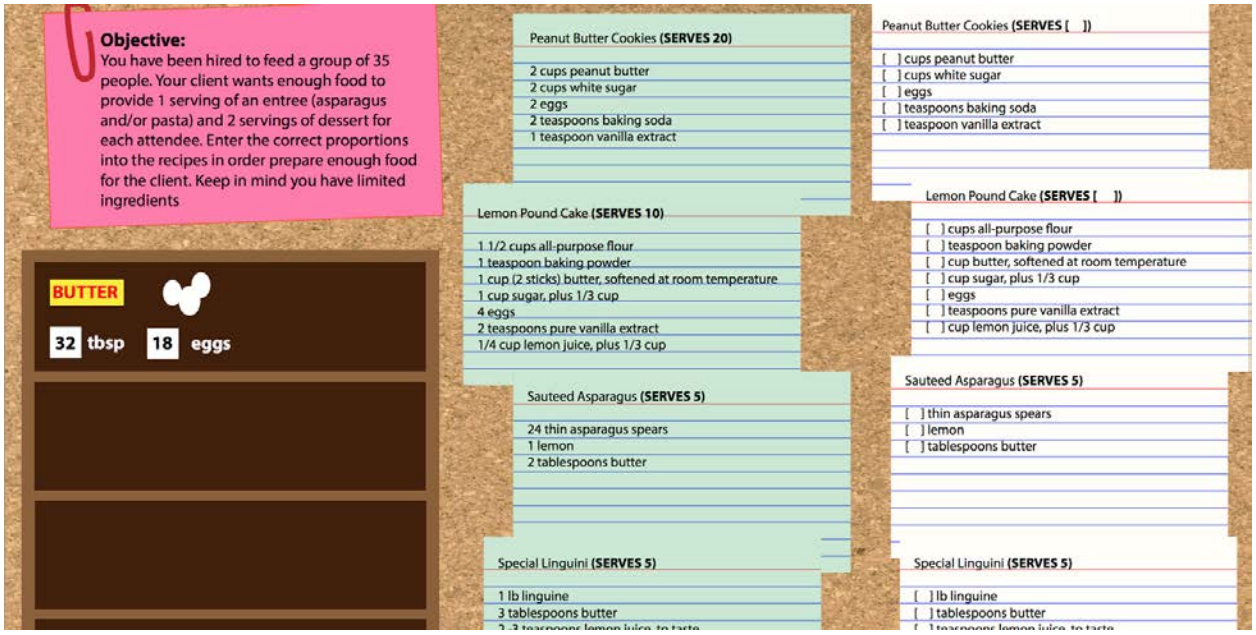
For each level, the player receives real-time feedback while building out the recipes, as well as detailed feedback after submitting the recipes. During the planning period (before the cooking is carried out), while the player inputs desired amounts for each ingredient in each recipe, the remaining amount of each ingredient in the cabinet is updated. Further, if the player attempts to use more of an ingredient than the amount available in the cabinet, the input textbox will turn red to inform the player that the attempted play is invalid. This direct feedback helps players work through the proportions and learn in real-time.

After the player submits the new recipes via the “Cook!” button, additional feedback is provided to indicate whether the client objective was met (i.e. enough food was made in Levels 1-3 and profit was maximized in Level 4) and whether the recipes were submitted with the right proportions. Throughout all levels, the player is outrightly told whether or not the client objective was met. However, the specificity and immediateness of the feedback regarding the player’s input of proportions of ingredients is designed to taper off as the player

progresses through the levels. In Levels 1 and 2, if the player fails to consistently scale ingredients in certain recipes, the feedback that the player receives pinpoints which recipes were not scaled consistently. Additionally, players who make the common mistake of adding/subtracting the same scalar amount to each ingredient in an attempt to scale it up/down instead of multiplying each ingredient amount by a constant will be explicitly reminded, “Remember to scale ingredient amounts rather than just adding or subtracting a constant amount”. In Level 3, if the player fails to consistently scale ingredients within a recipe, general feedback indicates “your dishes taste a bit off... Keep in mind that you have information about how each dish should be cooked!" but no information is provided on which recipes were incorrect, nor information indicating if the player committed the common mistaking of adding/subtracting scalar amounts. Finally, in Level 4, where the player is additionally asked to optimize profit, the feedback regarding proportions is given in a manner similar to that of Level 3, and players are informed whether they calculated the expected revenue correctly and if they achieved the goal of maximizing profit.

Implementation: Game design and development

The original paper-prototype of the game is shown below:



The developers then implemented this design using client-side code in JavaScript, HTML5, and CSS. The game in its current state is easily adaptable because each level information is represented as easily-editable JSON objects, and the the HTML objects and associated

listeners to update the cabinet amounts and total expenses (for levels with cost optimization) are developed dynamically. Upon clicking the “Cook” button, a JavaScript object is created with all the inputs, and a function is called to generate targeted feedback based on what the players inputted.

IV. User Testing

Eleven MIT students (selected as friends of the developers) play-tested the game. All play-testers already had a strong background in and understanding of proportions but were asked to play through the game by role-playing as one of two types of students:

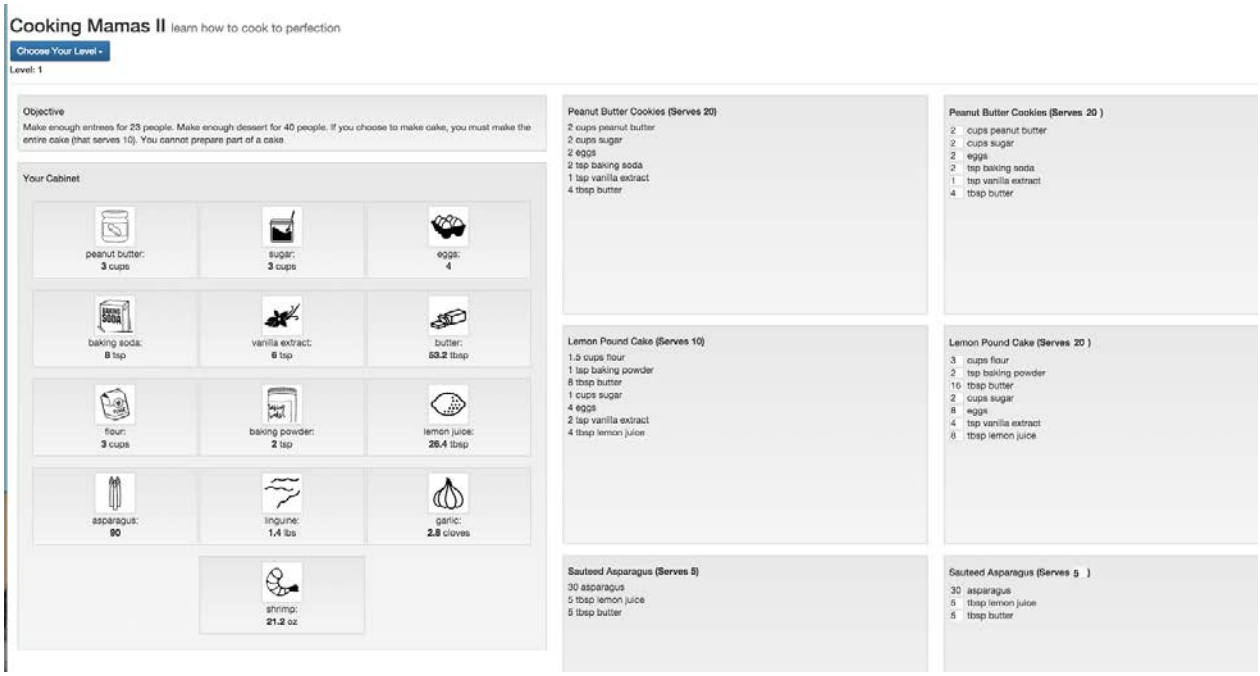
1. Middle school student with good understanding of ratios/proportions - makes mistakes ~10% of the time
2. Middle school student with mastery of ratios/proportions - makes mistakes <1% of the time

Before playing, each player was briefed on the context of the game (i.e. target audience, learning goals, potential implementation in classrooms, current stage of prototype). Each player was asked to play through Level 1 and one additional level. Afterwards, each player was asked to fill out a Google form (see the Supporting Materials section for the complete form) to provide feedback on the user interface, in-game feedback, achievement of learning goals, and degree of fun.

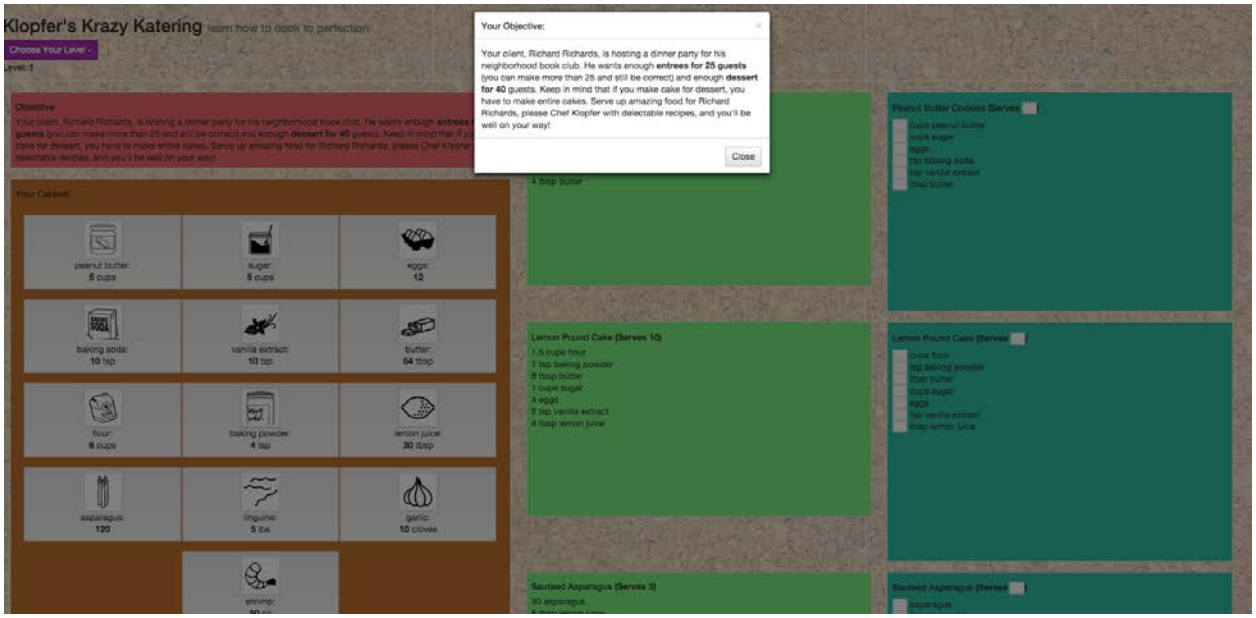
Test-players provided valuable feedback, and the feasible elements were implemented into the final version of the game, as evidenced by the before vs. after testing images of the game below. For example, Level 1 originally required players to scale the recipes by a mixed fraction, which seemed to be more difficult than the whole-number scaling in Level 2, so Level 1’s objective was readjusted to request players to scale the recipes by an integer. Additionally, multiple players suggested adding a storyline, color and pictures of the dishes to the screen to make the game more engaging and playful, so the developers correspondingly added characters, colors, and images of the entrees and desserts to the initial grayscale interface. Further, the objective first appears as a modal when the player selects a level and key parts of each objective (i.e. target number of entrees and desserts and dietary restrictions of guests) and post-cooking feedback (i.e. dishes in which the player did not input consistent

proportions) were bolded and/or separated from the storyline text to make them jump out as suggested by players with experience in UI design.

Screenshot upon selecting Level 1 - before play-testing:



Screenshot upon selecting Level 1 - after implementing feedback from play-testing:



Future Work

If we were to continue designing and implementing the game, we would hope to incorporate more diverse constraints such as minimizing cost for ingredients, limiting time for preparation and cooking, and introducing the need to substitute ingredients. We would like to direct the focus of the game to more real-world scenarios and more diverse challenges. Introducing new challenges would further push our players to develop their mathematical and problem-solving skills, giving them a more diverse learning space to practice those skills.

Adding time constraints varies the playing experience and keeps the game interesting. An example of a complex level involving a time constraint might be allowing the player 20 minutes, a given supply of ingredients, and a starting amount of money, then asking them to cater to as many client objectives as possible within that timeframe while also making as much profit as possible. This pushes the concept of optimization beyond the example we've provided in our prototype.

Another way to add complexity to the levels is to allow the player more choices in their gameplay. For instance, the player could be given a recipe box to pull from, which catalogs all the recipes they've seen in previous levels as well as some brand new ones if they want to experiment. After scaffolding with assigned recipes in earlier levels, the more complex levels could give the player free range to be the Krazy Katerer they were always meant to be! Essentially, continued development would result in ensuring that gameplay does not become static and that players are always being challenged to build upon their progress.

We would also want to have a very finely tuned feedback mechanism that is able to respond to specific errors in the player's input. For instance, if the player makes too many shrimp entrees and not enough asparagus entrees but all input proportions are technically correct, we would assume the player understands ratios and probably forgot that there are vegetarian guests. We would like to provide specific feedback in this case asking them to consider the vegetarians. On the other hand, if the player isn't able to correctly input the amount of ingredients in the new recipes, we would respond with the specific ratio that the player answered incorrectly and go through the thought process of how the student should be getting to the correct answer. If after multiple attempts the student still isn't coming to the right

answers, we would assume that the player still does not have a good grasp on proportions and would send this feedback to the teacher, point the player to other supplemental materials, and/or bring the player back to an easier level. Our ideal game would have feedback specific to each error the player could make in order to combat any potential misunderstanding he/she may have.

Another component we would add to our ideal game would be a more visual input mechanism. This could be dynamically responsive graphs to assist the player in visually comprehending the proportional relationships between the original recipes and the new recipes. This could also be represented by nixing the input boxes and allowing for a drag-and-drop feature in which ingredients visually accumulate or decrease (i.e. the player drags three eggs to the new recipe and the result is three eggs pictured in the new recipe). This feature would replace the current, static icon for each ingredient. Furthermore, another visual element to be added is the option to not only choose the numerical input, but to choose the metric unit as well. In being able to choose the unit, this provides the opportunity to convert between units as well. For instance, if multiplying a recipe so many times means you end up with 9 teaspoons of some ingredient, you can then convert this to 3 tablespoons of that ingredient instead. In providing the opportunity to make conversions, *Klopfer's Krazy Katering* provides an even richer experience with the real life simulation of ratios within recipes.

Finally, if we were to continue with our prototype, we would develop a storyline to guide the player through gameplay. The story line would illustrate the world of *Klopfer's Krazy Katering* and feature a boss- or mentor-type character that voices the feedback given to the player. This character would be animated and the feedback would be both audible and presented in pop-up speech bubbles. Clients could also potentially be animated characters, but to start client requests will just be shown as written orders. The general game screen would also be animated to look like a real catering kitchen, complete with cabinet and ingredients. Colorful and appealing animation is intended to be aesthetically pleasing and make the player feel like they are truly engaging with this Krazy Katering world. Providing the player with a boss/mentor to impress is an added motivation to play through the levels and make the best choices for the company. Furthermore, character and setting animation also allows the player

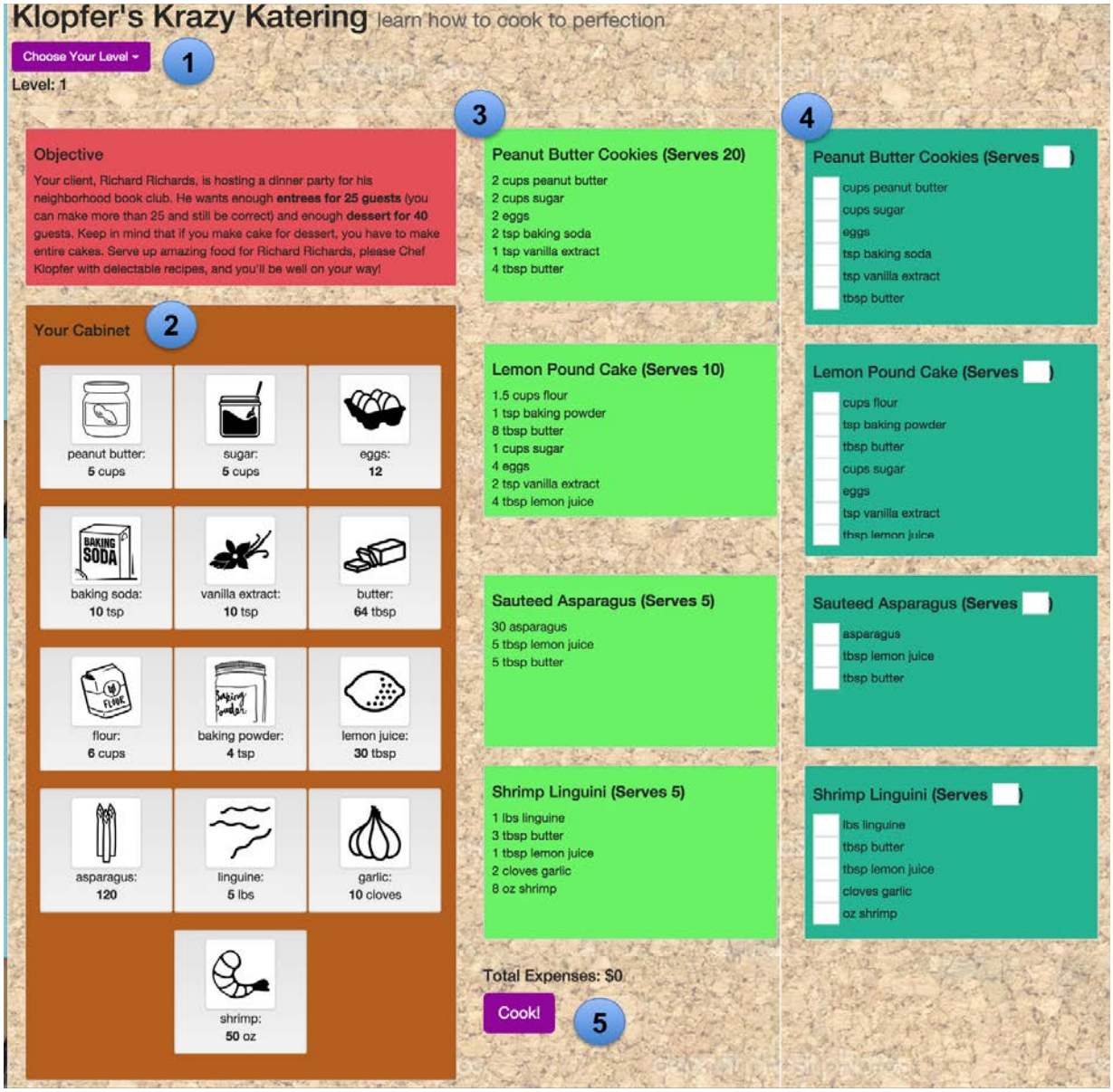
to envision the real-life scenario they are playing out. These plans for a storyline and animation will bring our game to life and pull players into the world of ratios and proportions!

VI. Supporting Materials

Instruction Manual

Welcome to your new job at *Klopfer's Krazy Katering* business! You've come just in time - the business is quickly growing and we need great chefs like you to help us meet our client demands and keep our 5-star rating! To get started:

1. Choose a level and take note of the corresponding client objective.
2. Check out the supplies available in your kitchen cabinet.
3. Look through the original recipes and note how many servings they each provide. In Levels 1-3, there are two types of entrees and two types of desserts that you can pick and choose from.
4. Fill out the new recipes to make the right amount of entrees (to the nearest hundredth) and desserts using the food available in the cabinet. Notice that the amount of food in the cabinet updates itself as you fill out your new recipes.
5. Press the "Cook!" button to send your helper chefs into action to execute the recipes with the amounts of ingredients that you provided and check out the feedback from Head Chef Klopfer afterwards!



User Testing Feedback Form

The user-testing feedback form - http://tinyurl.com/klopfers-katering-feedback - consisted of both scale and free-response questions, as detailed below:

1. General Information
    a. Name
    b. Assigned type of student (i.e. good understanding vs. mastery)
    c. Levels played

2. User Interface
    a. The on-screen layout of the objective, cabinet, original recipes, and adjusted recipes made sense: Disagree/Agree on a Scale of 1-5
    b. It was easy to learn how to play the game, given the instructions: Disagree/Agree on a Scale of 1-5
    c. The real-time updating of the available ingredients in the cabinet was helpful: Disagree/Agree on a Scale of 1-5
    d. The real-time feedback of the textbox turning red if I tried to use more ingredients than what was available in the cabinet was helpful: Disagree/Agree on a Scale of 1-5
    e. Any other comments on the user interface? Free response
3. Post-Cooking Feedback
    a. The feedback provided after submitting the recipe via the "Cook!" button struck a balance between being specific enough for me to pinpoint where I messed up and providing a challenging gameplay experience (i.e. less hints as the levels increase): Disagree/Agree on a Scale of 1-5
    b. How can we improve the feedback given after the user "Cook!"s the recipes?: Free response
4. Meeting Learning Goals
    a. This game will enhance student understanding of ratios/proportions: Disagree/Agree on a Scale of 1-5
    b. The difficulty of each level seemed appropriate: Disagree/Agree on a Scale of 1-5
    c. How could the game more effectively improve student understanding of ratios/proportions? Free response
5. Fun/Engagement
    a. I enjoyed playing the game: Disagree/Agree on a Scale of 1-5
    b. The game was engaging: Disagree/Agree on a Scale of 1-5
    c. How could the game be adjusted to make it more fun and engaging? Free response
6. Other Additional Feedback: Free Response

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