Kerry and Abbey Final Game Design - Fraction Bakery

Abstract: Describe the learning goals of your game, the premise, and the overall game design in just a few paragraphs. Describe the area, general age group, and skills you are going to teach your user. Make sure that these are skills, not just content. These need to be specific - not just "math" or "memorization" - exactly which math skills are expected or exactly what level of memorization is expected to be built? You also need the skills to show some range from easier to harder.

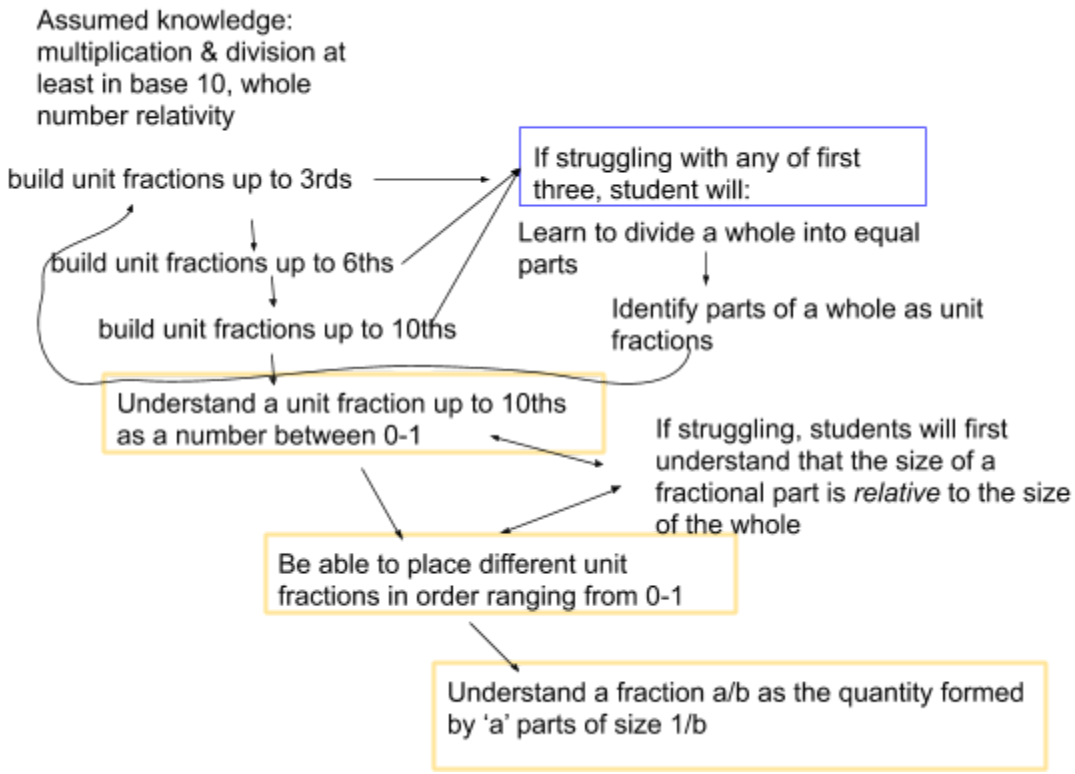
Fraction Bakery is a 2D computer game that walks the players through 3 different maps containing minigames. The player learns to become a professional baker starting from an entry level job and gaining expertise throughout the game. With points, badges, and level completion the player can gauge how much they have learned about baking and fractions, eventually owning and running the bakery they began working in.

Our learning goal is to teach 3rd grade children from different backgrounds basic fractions. Users can come in with little to no fraction background, and will learn to eventually understand what a non-unit fraction means (a/b). They will start learning what unit fractions are (1/a), then move to understanding them as a number between 0-1. After getting that down, the students will learn to compare different unit fractions to each other, and from there move to becoming familiar with what non-unit fractions are as the end learning goal. If a student is ever struggling in a category (not passing a minigame), they will be taken to a “bonus minigame” where they will grow their more basic understanding of that category before being allowed to move on. Throughout the game, players will understand real world examples of parts to a whole fractions, while their character learns to bake. By understanding how to equally share a cake, for example, then go back to how to make that cake with different measurements of how much flour, sugar, and milk, players will gain the tools necessary to understand basic fractions.

Our game is 3 levels, with each level having a focus on a different aspect of the learning trajectory. Each level has its own “minigames map” where the user traverses up a cake, or around a kitchen to enter different levels. Each level will then consist of an easy, a medium, and a hard minigame for the aspect of the learning trajectory that it covers. So the first level will have a focus on unit fractions, allowing the player to master this concept first. Once the user beats all the minigames on one level, which is required for the user to progress, they can move on to the next level, and eventually when they beat all the 3 levels, they will have won the game. The second level will take them through minigames focused on understanding fractions as numbers and relativity, and when they beat this level they can start the final level, which is focused on non-unit fractions. All the previously completed minigames will remain available at any time for the user to go back to and review. As the user plays the game, they will also be receiving points for each minigame, depending on their success on that minigame, and badges for a variety of achievements. These will be available on their profile to share with friends and peers. The

overall premise of our game is the user working in a bakery, and as they progress through the levels and learning trajectory, they are also learning new baking tasks and becoming a pro baker. The early minigames will involve simpler tasks like dividing a cake into equal parts, and by the end they will be adding fractions of ingredients into recipes.

Learning Trajectory: create a hypothetical learning trajectory for how student skills / knowledge will be built. The left edge should be the skills you assume students start with (lower anchor points). The right edge are the most advanced skills you will teach (upper anchor points). If there are concrete skills in the middle, you can highlight those with a different color. If you think it is more appropriate to split this into multiple trajectories, you can do so. Where available, cite sources for either the learning goals themselves or the relationships between learning goals. Much of what you are teaching has research behind it, so you should not be making all of it up.



Sources:

- Standard core standards for math and reading literacy and comprehension
- http://www.corestandards.org/Math/Content/6/introduction/
- https://www.education.com/common-core/fifth-grade/math/

- http://www.corestandards.org/Math/Content/3/introduction/
- https://www.education.com/common-core/third-grade/math/
- http://www.corestandards.org/ELA-Literacy/RL/3/

Game Design: Describe your game, taking care to describe the different elements such as premise, rules, etc. This needs to be a complete description that will allow the reader to understand the game play.

The game will consist of 3 levels each with a different focus on a few learning goals in the trajectory. The game begins with the user choosing a basic avatar/character to start playing with (eventually they will be able to use points to customize this character. Because points are being used as an indication of how well a user is doing, points won't be deducted ever, but they can get a new item at certain point checkpoints). The first level will consist of an easy, medium, and hard minigame for each learning goal (the first main 3 learning goals about learning the meaning of unit fractions). Each minigame will be laid out on a map that looks like a 3 tier cake (where each tier represents a level) through which the player will traverse to get to the end of the game. The user will move their avatar forward and backward to get to different minigame pins, and press enter to enter into that scene. Once the user completes the first level, they will move up the map to the next cake tier that includes the minigames for learning goals to understand fractions as numbers (the next two goals on the trajectory). Each of these learning goals will again have an easy, medium, and hard minigame. Once all minigames are passed on this level, the user progresses to the third cake tier to start the final level. Every past minigame and level will be always available to replay at any time. Upon completion of every minigame, the user will receive points based on their success in that particular minigame. The point system is out of 3, 1 being an attempt, 2 being good but not perfect, and 3 being all correct. Because the points available are not high in range, it limits the feeling of failure and competition for less high achieving users, while allowing others to use them as competition and achievement aspects of the game. The points will be displayed next to each level as little dots of frosting to tend to the baking theme as well as keep the numbers to a minimum. The students can also be awarded badges for doing things such as completing the first 3 minigames, logging on for 3 days in a row, completing 3 minigames on the first try in a row, redoing a minigame, and improving their score on a past minigame. Their points and badges will be available on their profile so that students can compare their points with friends and other students.

For the *Players* aspect of the game, this is an individually played game, so there is only one player, and that player is someone trying to learn fractions, specifically targeted towards 3rd graders. The *Objective* of the game is to win each minigame in order to progress through all the levels and become proficient in each point of the learning trajectory. From a non-structural

standpoint, the character learns to run a bakery by first doing easy tasks such as dividing cannoli evenly between 3 people, and then eventually getting to harder tasks such as completing a full recipe. Each minigame has a separate objective, and the main objective is to complete every minigame in all 3 levels. The *Procedures* of the player will include going from minigame to minigame, and playing each one until they win it, and progressing from level to level by doing so. They also can choose to go back to any past minigames at any time if they feel they need more practice in a topic. The *Rules* the player must follow are that the user cannot go to the next minigame without beating the one before it. Also, in the same manner, they cannot progress to the next level without winning all the minigames in the one previous. Also, if they only get a cumulatively low enough number of points for a level, they might have to do an extra minigame to help them more smoothly progress through the learning trajectory since they had a bit more trouble. This could be seen after level 1, if the user struggled, they would need to do an extra minigame to help them understand the size of a fractional part is relative to the size of the whole, which reflects the extra path we have for this in the learning trajectory. The *Resources* of the game would be the points they receive based on how well the user completes a minigame. A user may also gain badges for things like completing a minigame on the first try, and completing multiple minigames on the first try in a row (full list above). Users may use their points to customize their character. The *Conflict* that the user is facing is that the user wants to beat the game by reaching the end of the last level. To do so however, they must beat each minigame, and they will be able to progress faster if they receive more points by winning the games in one or two tries and not being required to do extra levels. The eventual *Outcome* of the game involves the user eventually beating all the minigames and levels. It is uncertain how many points they will end with, and the route they will be required to take to get to the last level, as they may have to do extra minigames. At the end of the game, the character will be a “pro baker”, have an understanding of non-unit fractions, and a customized character. As for the *Play* aspect of the game, the players have the choice of going back to play levels they enjoyed or need to review, or customizing their character with their points. There are also opportunities for creativity such as decorating a fraction of a cake.

Skill Building: Describe how the game gets more challenging as users learn skills, using vocabulary from game design.

Coming in, the users are expected to have little to no previous knowledge of fractions. Each level includes a subsection of the learning trajectory. Each level has minigames for each goal in that subsection, and for each goal there is an easy, medium, and harder minigame to concretize that goal for the student. If a student is ever struggling, they will be sent to bonus minigames that help them go back to the basics of that category, and then they will be able to go back to get a better score in the minigame they were struggling with. This scaffolding of bonus games as well

as tutorial-like hints will only be used when necessary, but will allow the game to flow in such a way that the user feels equipped to succeed, while also being challenged. The second and third levels will also have review minigames from the previous levels to help with the spiral learning trajectory.

Because bakery items are pretty universal, the students incorporate constructionist learning methods in the visualization of fractions in the world around them. The levels and minigames not only build on the user's knowledge of fractions, but also on their knowledge of fractions in relation to baking. To increase complexity and difficulty, the character will start with simpler bakery tasks such as cutting an already baked cake into equal portions, and move on to harder tasks with more elements such as making a recipe order with multiple steps. To motivate all skill levels and promote active learning, we have a badge and point system, as well as our customizable avatars to encourage kids to continue learning and playing our game.

Badge System: Describe a badge system that could be integrated into your game. Take care to describe three categories of badges. Make sure that your badges are tailored to your game. I can make a generic badge system that could be used for every one of your games. The purpose of this is to think about how to make them uniquely designed for your game:

- Participation badges
    - Our game will include participation badges such as a badge every time they complete a level, regardless of points. They will receive a badge every time they complete a certain type of minigame for the first time. An example of this is, in the 3rd level there is more than one minigame with the premise of the user completing a recipe, so the first time they complete one of these minigames, they will receive a badge that says "recipe master!"
- Achievement badges
    - Our game will also include achievement badges. One achievement badge we will have is the first time they complete a minigame on the first try, they will get a badge. Another would be every time they complete 3 minigames in a row in one try. Another will be if the user completes a level with a high number of cumulative points for the minigames on that level. An example of this would be if

they finished level 1 with a high point score, they would get a badge that says "unit-fraction cake connoisseur"

- Badges that are for behaviors that lead to academic success (in between participation and achievement badges)
    - Finally, our game will also include badges that are for behaviors that lead to academic success. One of these will be a badge every time they log in for 3 days straight. This encourages the student to, if they are able, remain consistent in their learning of fractions everyday, so that they don't forget anything they learned if it has been several days. Another badge would be if they redo a minigame, and get a better score than the first time, they would receive a badge that said "comeback cookie". This would encourage them to go back to topics they may have struggled with the first time and review and improve.

Motivation: Describe what elements you included to engage the player, again using vocabulary from game design. Describe how different "player types" will find something that engages them.

Our game includes several elements that are made to engage different "player types" so that the game is not just motivating for a specific type of student. For *The Competitor,* since the number of points and badges a student gets is visible to other students, they will be able to see how their friends are doing and try to get high scores, and achieve different badges, which would engage the competitor. For *The Explorer,* the user will get to push their mental boundaries through progressing through the learning trajectory, as well as apply it to things they see in real life with the baking theme, which will engage the explorer. They can try new recipes, in real life, and in the game or see what different combinations of ingredients make! For *The Collector,* the users will be collecting points as they go, and will be able to collect more or less based on their performance, as well as collecting badges throughout the game, which would engage the collector. They will also reach point checkpoints when they can collect new items and styles for their avatar. For *The Achiever,* the game has increasing difficulties of minigames within levels, as well as different levels that users must progress through, which would engage the achiever. Having their points, badges, and avatar available for them to see as well as others will help the achiever track their progress. For *The Joker,* the minigames will allow for some fun activities that would engage the joker more than just strictly learning fractions would, such as decorating a

third of a cake. The custom avatar is also a place where the Joker can get away from "traditional learning" while having to learn on the way. For *The Artist,* there will be opportunities for the user to customize their character however they please, as well as activities like decorating cakes in the minigames, both of which would engage the artist. For *The Director,* the user will have the power to go back and review anything they choose before moving onto a new minigame or level, which could engage the director. For *The Storyteller,* the game revolves around a story of the user working in a bakery, allowing the storyteller to live in a world of fantasy. Based upon what badges they collect, how they customize their avatar, and how they traverse the levels, the storyteller can fill in some personal parts to the already interactive storyline. For *The Performer,* though the game offers little opportunity to perform for real people, the game does have the user play minigames where they are completing tasks in their bakery with fractions for "the customers" of their bakery, which could engage the performer. If they get really ambitious, the performer can potentially cut pastries or do some of the things they learned in the game for their families or friends! For *The Craftsman,* some of the minigames will allow the user to eventually create a recipe using fractions, which will allow the craftsman to build and puzzle out a situation.

Designing for the User: Include the user profiles. Explain how you took into account the limitations in skills of the user to influence your game design.

Our user profiles were as such:

Mythical User 1
Category: (inspired group member(s) or not inspired by group member(s))
Age: 8
Hobbies: Sports
Stage of life (e.g. child, teen, single, parent, empty-nester, grandparent): Child
Personality: Extrovert, Friendly
Highest level of mathematical skills: A little ahead of normal, can multiply and divide within 150, can perform multi-digit arithmetic, understands basic unit fractions

Highest level of reading skills: A little behind, but can determine story themes, basic figurative language
Level of technical skills: Understands how to use a computer. Can type pretty well.
Devices owned: Family computer
Other relevant skills: Good at soccer, first language is Spanish
Generations lived in the US: 3
Cultural background: Argentinian
Gender: Non-binary

Mythical User 2

Category: (inspired group member(s) or not inspired by group member(s))
Age: 9
Hobbies: Violin, knitting, painting,
Stage of life (e.g. child, teen, single, parent, empty-nester, grandparent): Child
Personality: Introvert, creative, curious
Highest level of mathematical skills: A little behind, but can perform operations in base 10 and conceptually understands fractions
Highest level of reading skills: Can quote and explain parts of texts, figurative language, compare and contrast stories
Level of technical skills: Can use a smartphone as well as a computer pretty well. Knows how to type and navigate those devices.
Devices owned: An old ipod, family computer
Other relevant skills: Knitting, play the violin, painting
Generations lived in the US: 2
Cultural background: Italian
Gender: Male

Mythical User 3

Category: (inspired group member(s) or not inspired by group member(s))
Age: 8
Hobbies: Reading, gaming
Stage of life (e.g. child, teen, single, parent, empty-nester, grandparent): Child
Personality: Ambivert, curious
Highest level of mathematical skills: Operations in base ten and with multi-digit whole numbers, conceptually understands fractions, interprets numerical expressions
Highest level of reading skills: A little advanced, can read at a 5th grade level, can compare and contrast characters, determine story themes
Level of technical skills: Can play games on computer and ipad, doesn't type that fast, but can do so.
Devices owned: family computer, ipad
Other relevant skills: Likes to build things/good at legos
Generations lived in the US: 1st

Cultural background: Vietnamese
Gender: Female
Explain what skills this user lacks that you have that you will need to accommodate when you design your game: This user is not that fast at typing, but this game will help with that as well as have opportunities for dragging answers/ selecting things and won't always require typing within a game.

We considered these mythical users when thinking of different accommodations we would need to include in our game design. For User 1, they are a little behind in reading comprehension skills, and tend to read a little slower than others. The game will be designed in such a way that whenever the user has to read instructions or information, they will not be penalized on how slow or fast they read it, and will be able to move to the next step at their own pace. Reading fractions and equations at a normal pace should not be a problem for this user. For User 2, he learns at a slower pace and tends to do better with hands-on learning rather than reading directions. To accommodate for this, the game will have interactive tutorials that will be available to play as many times as desired and even return to at any time. For User 3, she is not that fast at typing, but this game will help with that as well as have opportunities for dragging answers/ selecting things and won't always require typing within a game, and when typing is required, it will not be for time, so typing slow will not hinder her ability to beat the games. The learning trajectory and bonus minigames are made to account for the user's maths skills, and allow students to learn/play at their own pace. As for technical skills, the game controls are always simply and clearly stated, and are meant to be intuitive and simple for every task. For example, moving to the next minigame only takes one press of the right arrow key, and this is explicitly stated on the levels map.

Culturally-relevant Instruction: Explain how you designed the game to appeal to students whose cultures do not fall into dominant American culture. What specific game elements did this affect, and in what way does that follow strategies we learned about culturally-relevant instruction?

One aspect of our game that is designed to appeal to students whose cultures do not fall into dominant American culture would be the character customization aspect of our game. The user may design their character to look like them (or however they want), and style them in different outfits, where there will be plenty of outfit options, and different options will reflect different cultures. That way the user can create an avatar that reflects themselves most accurately

or however they wish to express themselves. Whatever they choose, there is a personalization option available for user's avatars in which they may even connect to contemporary culture through clothing or hair styles for example.

We also chose an overall theme of baking/bakery, because the majority of cultures across the world have all sorts of baking recipes, as it is a very universal activity, just like cooking. It is normal to not have a lot of knowledge of baking as a 3rd grader, so the premise is hopefully not intimidating to begin with. On the other hand, learning to share/portion food, and bake or interact with foods they have seen before or could potentially make in real life are common actions that kids can relate to or imagine, no matter their background or situation. Also, in certain minigames, the user will be able to choose between several different pastries they are working with, so if they want they can choose to play the game using a concha rather than a cupcake for example.

UDL: How would you incorporate universal design for learning to accommodate students with sight impairments, hearing impairments, and/or cognitive impairments?

To incorporate universal design for learning to accommodate students with sight and hearing impairments, our game will have instructions on the screen, as well as having it available through audio. That way a student with any type of hearing impairment who would struggle with just on screen instructions they would be required to read, could hear them said out loud to them. Students without hearing impairments, as well as students with cognitive impairments can also benefit from text-to-speech to gain a better understanding of the game. Beyond this, for the students with hearing impairments, they will be able to read all the necessary instructions on the screen, and there will be no sounds from the game that are mandatory to hear in order to be successful in the game. For example, if a game has a celebratory sound that plays when the user completes the game successfully, the user would also know they completed the game successfully through a pop up of a word or picture on the screen. This ensures a user with a hearing impairment would not need to hear that sound to know they won.

Also, game elements are made to be seen with all types of color vision (making color contrasts easy to see and not overwhelming). This will help all users not over exert their eyes, along with adjustments available for text size, and screen zoom. As for the actual game, all types of people will be represented as customers including those with impairments (and users will have the opportunity to customize their avatars with glasses or hearing aids for example if they so

wish). And because our game is single player, and is made for students to learn and play at their own pace, different motivations are meant to tend to every type of player. For example, one player may have more points, but another may have cool cakes or badges or an avatar. The bonus minigames are another aspect of the game that is meant to keep all users focused on their own learning while still having fun and creating their own path. Using hints, or bonus games are never penalized, and are sometimes encouraged!

Intelligent Systems: How could an intelligent system be used in your system to adjust game play based on user play? Hypothesize a design that would dynamically provide personalized feedback and choose the next level / task / etc.

For an intelligent system for our game, we would want to first include a domain model with the skills, knowledge, and strategies for our topic. This model would include the breakdown of the learning trajectory, so unit fractions broken down into ⅓ s, ⅛ s, and 1/10s, and then relativity of unit fractions and being able to place them in order, and finally non-unit fractions. The model will also contain common misunderstandings users often have, such as the misunderstanding that ⅛ is larger than ¼ since 8 is larger than 4.

We would then want to have our learner model, which would track how the user is doing relative to the domain model, and this would change over the course of the game. It would follow the user as it goes through each minigame and determine where the user is finding success and where the user is struggling. For extra effectiveness, the learner model can keep track and consider psychological states of the user, as this could be relevant to the users success and academic performance. Depending on the user's state, the IS could provide more hints or encouragement throughout the game.

We would then have the tutor model, which would consider both the domain and learner model, and from this determine what the next best step is for the user. Some good examples of this would be if the user is struggling with unit fractions, as we have in the learning trajectory, the tutor model would determine that they need to learn and understand breaking a whole into several equal parts, and then identify those as all a certain part of the whole, before they can return to learning unit fractions. Another example of this that could take place in our intelligent system for our game would be if they finished unit fractions but struggled, the tutor model would determine they need to learn and understand how a fractional part is relative in size to the size of the whole, before they are able to move understanding how to order unit fractions and relativity.

Adding these to our game interface would make the game more personal and better suited to each player since it would dynamically determine what they need to do next, and what support they need from the game in order to be most successful in their learning.