Project Final Report

Lil' math chef : fractions learning game

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Ali, Yasmeen
Finnigan, Evan
Kaba, Jameel
Kajendirarajah, Usant
Jones, Duff
Ortega Santos, Pedro David

Executive Summary

Lil' Math Chef is the name of our app, which is intended to help teach how fractions work. This is done through the use of three game modes:Practice, Are We Equal?, and Match Game. In Practice mode, the user will be able to play around with fractions and see the resulting changes to an image which represents the fraction the user entered. Are we Equal? is a very simple comparison game where the user is given an image of shapes representing fractions alongside numerical values. The user is then given the choice to decide if the two are equal or not. Finally, the main game mode is Match Game. In this mode, the user is given three difficulty levels to suit their level of comfort with fractions. When playing Match Game, the user has to match shapes representing fractions with their appropriate numerical value in order to score points.

System Map

Splash Screen

- Game Select
    - Instructions
    - Practice
        - What is Practice Mode?
        - Go to Practice Mode
    - Match Game
        - Beginner Matching mode
        - Intermediate Matching mode
        - Expert Matching mode
        - How does Matching Mode work?
    - Are We Equal?
        - How does Equality Mode work?
        - Play Equality Mode

Design Principles Used

Accessibility-

This app has been developed with a target audience of children in Grades 4-5 in mind. As adults, it is difficult to remember what is understandable by younger audiences, time has been dedicated to choose the correct choice of language that is easily understood by the target audience.The design of the app has been catered towards the literature abilities an average grade 4 student would be used to reading in their textbooks or age appropriate novels. (UPD, 16)

Advanced Organizer - Provide users instructions to understand what they are supposed to do in each game mode under each specific difficulty. The app implements a comparative sort of organization, by use of text based instructions, since the app considers their age (between 9-11 years old) is familiar with matching game mechanics. (UPD, 18)

Aesthetic-Usability Effect - Improvements have been made to create a simple yet captivating design to engage users with the app. This is done through improving aesthetics in comparison to the initial prototype. As a result, the revamped app is simple and easy for the target audience to perceive and understand. Provided visual elements such as choice in colours, buttons, these engage users to remain motivated towards their perceived task.(UPD,20)

Affordances - The app applies a “doors resemble real doors” with the buttons in the app having the affordance to be pressed. For example, the menu buttons in the app which can be pressed at any point in time while in any game mode by the user. Another affordance is that of the text boxes in the practice mode, which can afford to receive writing from the user by typing on them Another affordance placed is in the matching game mode, where oven doors are placed and the user is able to open them by clicking them. (UPD, 22)

Alignment - In the application the elements are clearly organized to appear together in terms of fractions/images of fractions through the use of row/column alignment. Both an aesthetic and practical portion of the application, text and item alignment is critical to the outlook of the final product. As this would be very important to the application, especially towards elements such as the instructions section prior to each activity or minigame in the application**.** In the instructions, keeping a left aligned text for easier reading, centered game mode titles and centered text on buttons to increase ease of reading. (UPD, 24)

Chunking - Dividing the sections of the game modes into smaller units and allowed the player to focus on certain aspects at one time. Levels are progressively more difficult. Different levels of difficulty are chunked together. Chunk together questions with similar difficulty. (UPD, 40)

Classical Conditioning - provided a reward system based on answering the questions, so that users are conditioned to want to succeed. For every point earned, a little happy ding would sound off and for questions the user would answer wrong, a buzz sound would be heard. (UPD, 42)

Color - Used https://www.colorhexa.com/ site to ensure that color used were appealing, of a sizable variety and presented a calming atmosphere to help focus on the task. (UPD, 48)

Comparison - The app contains an “apples to apples” section, where the user is matching different representations of the same fractions. This is so they begin to reflect on the abstract math inplace of seeing simply numbers, enforcing them to begin applying mental math when faced with fractions. (UPD, 53)

Consistency - all screens use a common language/aesthetic approach
The choices made regarding the overall theme, color, positioning and font of the app were conscious decisions made in order to improve the experience of the app. By letting the user know what to expect

from one screen to another in the app, the app becomes easier to use. These thematic decisions lead to a reduction in distraction for the user, as they do not have to try to find where things are on the screen or re-learn anything (outside of the different game mechanics) when moving from screen to screen. (UPD, 56)

Constraint - only a few things possible at any given time; don't provide all the options at once
The app once again took into account the target users and their age, ability but most importantly their goals. The app's main intent is to teach fractions, so control and actions the users can carry out needed to keep this in mind. For example, in keeping game modes apart, only showing specific question in certain game difficulties, to reduce the possibility of confusion an unintended mistakes (UPD, 60).

Depth of Processing - accomplished by using reflective techniques talked about in Professor Sedig's research in order to get the player to be more likely to remember how fractions work. Rather than have simple click and drag mechanics throughout the game, the user is required to input a number into a fraction numerator so it matches the image or corresponding equivalent. This way, the use to think and consider the fraction as a whole is encouraged and the user thinks more about their answer and mental math. (UPD, 72).

Entry point - simple opening screen with obvious options; tutorials for each mode, as well as brief and concise set of instructions for each mode. (UPD , 80)

Garbage In-Garbage Out - anywhere where there is user info entered (e.g., their name, a fraction), there is a limit to the information given to the user to prevent them from giving unusable information. Invalid characters are unable to be entered in the numerator section, for example. Valid characters in the practice section can be entered and, will result in an appropriate response to the user on screen. (UPD 112)

Gutenberg Diagram - used to organize important info. For example; the layout of the "matching mode" game mode. The setting is made so the question, and menu and reset buttons are closests to the primary optical area and strong fallow area, while there is no buttons or important interactions in the weak fallow area .(UPD, 118)

Hick's Law - minimize the choices. By making the game progression based, the number of choices is minimized for a newcomer user that is first learning to play. (UPD, 120)

Hierarchy - The system has a hierarchical stairs structure. The parent elements of these stairs being the main screen, practice, matching and are we equal modes, with the child elements being the instructions, each minigame, and the option sections . (UPD, 123)

Highlighting - Use of fonts, size, blinking effects to make it obvious what the user should be focused on at any given time. The items in the center of the game (the fraction calculator, the matching cards, the fill in

the blank fractions) are large and clear for the user to see, as well as include the reset and menu buttons on the top of the screen which are highlighted when the mouse hovers over them. (UPD, 126)

Iconic Representation - Using symbols to represent mathematical principles. For example, using images of pizza ins various slices inside a circle of specific fraction. Aslo, using oven doors that hold a certain fraction inside of them.(UPD ,132)

Immersion - provide challenge at a reasonable level by taking difficulty into account. By providing a challenge, the app introduces an element of competition and possible drive to users that use the app. The higher the difficulty, the higher in complexity the questions will be, and enforce a higher need for critical problem solving and fraction application to solve correctly.(UPD, 134)

Inattentional Blindness - All information is located near where the user would likely be looking; if not, blinking and colors are used to draw attention. When in the matching game, for example, the user can see which card he selected based on the card color change so they do not lose track of their card to find its missing partner match (UPD, 136)

Layering - Only one aspect of the system available at a time because of the use of 2D layering, as such the user can only see one page at a time and cannot move onward unless they interact with the appropriate button. (UPD , 146)

Legibility - large text/font; easy to read. The text size was to be chosen so as to not encumber the entire focal view of the screen, both eliminating any space for the game pieces or even menu icons, but also large enough that most can see it.(UDP, 148)

Mental Model - use of known interactions of this type of system to activate users' existing mental models. One of these interactions regards that of a matching game, as the pieces are organized in a numbered set of rows and columns, to trigger their mental model of a matching game. In the equal mode, an equal sign is placed between the number and the image to trigger the idea to the user to compare the quantities present and decide if they are the same or not. (UPD, 154)

Picture Superiority Effect - Taking advantage of the fact that people remember images better than words/numbers in order to help them recognize fractions. As such, the starting difficulties in the app use iconic images (squares, circles) that children have seen being cut or divided into equal parts such as a pizza. (UPD, 184)

Performance Load – The app first introduces the fractions by providing simple and easy expressions, easy to recall and problem-solving tasks to reduce the incorrect input. As they progress in each level, the app continues to increase the level of difficulty and increase level of punishment for their decisions. (UPD, 178)

Progressive disclosure - Making modes available as user demonstrates skill. Depending on their performance and progression (playing the game in various levels of difficulty). The user will only see

difficult questions if they select the higher difficulties, allowing separation in understanding and comfort between basic, intermediate and advanced forms for fractions.(UPD,188)

Readability - simple reading level for younger students. Agewise, grade 4-5 students need simpler use of language and instructions than adolescent or adults, so the app text was set to their reading level, only relying on words they know and avoiding high level words which they might not know the meaning of. As well, when considering the printed text, a clear and simple text style in which is easy to identify and differentiate was the more optimal choice. This was also implemented in the buttons so as the user would be well aware of what pressing the button would entail (UPD, 198)

Recognition Over Recall - some recall required , but the app provides as many elements as possible to allow the user to recognize mathematical concepts, using numbers or images of whole items or simple fractions they can quickly recall from their lessons or previous encounters and give them the task to find its correct match or recall if the number and the sliced up food have quantitative equivalence (from the are they equal mode). (UPD, 200)

Signal-to-Noise Ratio - The system is made as “bare” as possible to focus on the immediate goal -- teaching fractions. Keeping amount of buttons as small as possible, to reduce distractions. This means a conservative use of on screen interactive buttons, little to no background moving objects, and use of sound effects that while reinforce positive or negative results that do not distract the user's cognitive function when trying to solve the level.(UPD,224)

Visibility - clear display of what can be done at any time. This is accomplished by making the proper tools and interactive objects for specific game modes appear and remain on screen only while the user is in that apparent mode, and once they leave a certain game more those features disappear and are replaced by the options of the newly selected mode. (UPD,250)

Wayfinding - user always knows which game type they are in and how to return from where they are to other areas in the program. The application provides titles at the top of each minigame or in the pages leading up to each respective minigame (IE: select difficulty, select game, etc…), to clearly and directly inform the user they are entering into a new part of the app**.** (UPD,260)

Heuristic Evaluation

Below are the heuristics evaluation derived for each category.

1. Interaction & user activity

Does our app provide user control and freedom(navigation)?

The app gives the user control and freedom to perform actions they can reset the game and return to game select screen at any level of game.

Does our app provide quality of actions?

Various possible actions are provided by where user can type set of numbers to test correct input, doors are the key to go to next level, buttons to enter, exit or to change sounds throughout each game modes.

Does our app provide clear goals?

The app provides clear short goals in every mode via its instruction page.

Does our app provide immediate feedback?

The app provides immediate feedback through positive dings or negative buzzards for correct and incorrect response to a question respectively.

Pleasurability

Utilizes pizza images in fractions along with sound and music content for further immersion of player in the game.

2. Interactivity

Focus

Maintained the app with the least number of distractions by minimizing the number of buttons for accessing other parts of the game, while maximizing the shape and attractiveness of the task at hand

Flow

Small task to complete pizza fractions are provided at each mode which will make users task focused till they reach to next mode.

Engagement

By providing simple fractions with different fun modes, keeping user engaged with the game using their skills makes the app a powerful learning tool.

Time

Fast response between user interaction and application response

3. Metaphor, semiotics, representation

Familiarity

User can apply prior knowledge of mathematical concepts to accomplish tasks, simple language and images are used as metaphors

Screen layout

Player will experience the interface as efficient and integrated with recognizable images and components that clearly shows their functions.

Are functions recognizable?

Almost all visual elements allow user to recognize mathematical concepts but still some recalling is required while playing. The act of multiplication or division is dependent on the user apart from the game itself.

4. The way the design is perceived (Part 1)

Does our app provide consistency and standard?
Consistent visual elements are provided in all screens. Colors, text fonts, background is in harmony in every mode.

Is our app well illustrated?
Users can understand the individual interface elements of the app. The use of illustrations is appropriate and straightforward, as the team avoided overusing an item for more than one intended purpose. Consistency; background color, button symbols for menu options, matching items mainly involved pizza at beginner levels.

5. The way users learn the system (Part 2)

Learnability for new users?
common aesthetic approach is used throughout in app for new or experienced user that can maximize interaction and performance.

Simplicity
Through use of limited color backgrounds, clear interactive buttons and fill squares, and consistent sounds, the app maintains an overall atmosphere of uncomplicated interactions with the user, preserving simplicity.

Does our app provide proper help and instructions?
The app provides instruction screen which users can access through buttons provided

6. The general usability of the system (Part 3)

Flexibility and Efficiency of use
Once user go through instructions, they can easily and quickly perform tasks with given options and can access main screen at any time.

Visibility
Provided with the help of interactive objects in specific modes while user performs task.

Aesthetic-Usability Effect: as this app is an educational but game based tool aimed for young audiences, it requires an overall colorful appeal. This, in turn, is why the team selected the specific colors and figures for the app; it diverts less attention from the user and their goals to learn fractions. While it

contains some more decision intensive controls to solve the levels, the overall appeal increases user acceptance of this change.

Does our app provide well organized menu?
Fractions are broken into three smaller units in a well organized and minimalist manner for each mode so that kids can have on certain aspects at a time.

Does our app allow to customize settings?
The app provides option buttons in each game mode to change sounds, music or simply exit the mode. These can be done throughout the game; from the starting screen to even the various game modes.

Recommendations for Improvement

The application was able to take and advance in several areas from its predecessor, although there were some additional features and implementations the team desired to have available to improve the application.

Larger variety of game modes
Due to time constraints, the group could only create and implement a limited number of game modes that felt would maximize a user's learning experience. If given more time, more implementations could be added to exercise user understanding of fractions by making the activity more time based, emphasizing on both speed and accuracy of mental math. Another feature could be one where the user gets 3 chances to answer questions or else be forced to start from the beginning of a set of questions.

Audience appropriate testing
If given the opportunity and resources, the team would gather a group of possible users to test the prototypes and obtain their opinions during the development of the app. This way, the team can better tailor the game to the needs and understanding of the target user audience and have an effective and educational tool that can be readily used. The testing would be two fold: take a group of children of the desired target group and test their current skill in fractions, and record their results. Put them to play the game for a defined period of time and have them take another fraction based test based on their results with the game and record results and analyze improvement.

Online leaderboard / high score
With more time, the application could have a working online leaderboard. It would simply be used to add to the competitive atmosphere of the game. Another application would be an offline high score system, that would record the number of correct questions user has answered under a certain time frame.

Alternative tutorials
Rather than a simple text based instruction page for each game mode, the app would implement either a practice level with multiple aids, suggestions and in game instructions or demonstrate the game via audio

visual presentation. Just as well, the team could create tutorial videos that would describe what each game mode entails and the sort of actions the user needs to carry out to surpass each mode. These would be optional for the user to take, and could be skipped by the push of a button and be available by hitting another button while playing the game.