

HCI Project: Computer Game Design and Development

Anna Dubé

Athens State University

adube@my.athens.edu

00091750

November 22, 2021

Table of Contents

PACT Framework	3
People.....	3
Activities	3
Context.....	3
Technologies	3
Personas	3
An elementary school aged child	3
A college student	4
Someone in their 30's	4
A senior citizen	5
An elderly person.....	5
Scenarios	5
An elementary school aged child	5
A college student	7
Someone in their 30's	8
A senior citizen	10
An elderly person.....	12
Interface Design	13
Accessing the Game.....	13
Choosing a Game	14
Playing a Game	14
HTA Diagram	16
Planned Steps	18
Game Functionality	19
Questionnaire and Interviews	23
Participants.....	23
Representative Tasks	24
Measurements	24
Outline Plan	24
Questionnaire	24
Results.....	25
Application Modifications	30
Results.....	30
Modifications	31
Questionnaire Design.....	33
References	34
Appendix I	35

I. PACT Framework

The PACT framework is used to design systems. This framework is used to document information in four different areas: People, Activities, Context, and Technologies.

a. *People*

- The users will be people of all ages that enjoy number games.
- Not all users will know how to play these games.
- Some users, like elementary aged children, may not be able to play the games well.
- The users will probably be from various countries, so things like different languages need to be taken into account.
- One design issue is people with limited use of their hands may be unable to enter data.

b. *Activities*

- The purpose of this activity is to entertain and to challenge the users.
- Since there is a wide range of users, there is no peak time of usage.
- Both games deal with numbers so the only data that will be entered is numeric data.
- These games are single player games.

c. *Context*

- This activity can take place anywhere.
- This activity will usually take place when the user is alone or with a few other people. It may occur in a public setting, like in school.

d. *Technologies*

- Data has to be entered and checked.
- There needs to be some way for beginners to learn how to play.
- There needs to be output that tells the user if they have won or lost.
- There needs to be a way for users to solve the problem if it is too difficult for them.

II. Personas

This section describes five possible personas that may use the application. The users' goals, limitations and skills are recorded. This information is used to aid the designer in understanding the possible needs or wants of the different users.

a. *An elementary school aged child*

Name: Jim

Age: 8

Grade: 3rd

Location: Illinois

Likes: Playing video games

Technology Skills: Uses technology at school, knows how to use school desktop computers, laptops, and iPads, owns an iPad.

Goals:

- Find new ways to entertain himself.
- Learn how to play a new game.

Limitations:

- Needs permission from parents to get new games and to use his iPad.
- Is only allowed to play video games for a certain amount of time.

b. A college student

Name: Rebecca

Age: 20

Major: Mathematics

Location: Texas

Likes: Playing video games, likes solving logic problems, likes solving math problems

Technology Skills: Moderate computing skills, has taken several computer courses as part of her degree, owns a phone and laptop, and uses technology frequently with school

Goals:

- Find a game that can entertain her during her free time.

Limitations:

- Does not have much free time since she is very busy with school and work.

c. Someone in their 30's

Name: John

Age: 34

Occupation: Journalist

Location: London

Likes: Playing board games and video games

Technology Skills: Basic computing skills, owns laptop, desktop, and cell phone, uses technology with work

Goals:

- Find something to do during breaks at work.
- Find something to do during spare time on business trips.

Limitations:

- Prefers games with competition.
- Does not have much spare time to play games.
- Prefers to spend spare time with family.

d. *A senior citizen*

Name: Mark

Age: 51

Occupation: Network Administrator

Location: Canada

Likes: solving problems, playing video games on his cell phone and laptop

Technology Skills: moderate to high computing skills, owns a laptop and cell phone

Goals:

- Find a new game to play.
- Find a new way to entertain himself especially during the winter months.

Limitations:

- Does not have a lot of spare time.
- Spends some time out of work answering emails and solving network problems for people.

e. *An elderly person*

Name: Rachel

Age: 85

Location: Idaho

Likes: playing card games

Technology Skills: Minimal computing skills, owns an iPad

Goals:

- Find new ways to entertain herself.
- Find a new game to play.

Limitations:

- Has minimal computing skills
- Has several health problems that may make it difficult for her to use the application.
- Not very interested in logic games, but likes games like High roll vs. Low roll.

III. Scenarios

This section lists many theoretical scenarios for the five personas in the previous section. The scenarios document possible user experiences which are useful in designing the application.

a. *An elementary school aged child*

High roll vs. Low roll

- People: Jim
Activities: Playing High roll vs. Low roll
Context: After school
Technology: iPad

It is after school and Jim has completed all of his homework. He asks his mom for permission to play games on his iPad. He decides to try High roll vs. Low roll. He has never played this game before. He first selects to view the tutorial and then returns to the menu and selects the play game option. He gets the rules for winning mixed up. He thinks that if he picks low and the number he chose is lower than the number rolled, then he wins. He becomes frustrated and quits the game.

- People: Jim
Activities: Playing High roll vs. Low roll
Context: Saturday
Technology: iPad

It is Saturday morning and Jim has been given permission to play his iPad. He decides to try High roll vs. Low roll again. He views the tutorial again before he plays the game. As he starts to play, he realizes the mistake he made before. He now understands how to play the game.

- People: Jim
Activities: Playing High roll vs. Low roll
Context: In the car
Technology: iPad

Jim and his family are on their way to his grandparents' house. He brings his iPad so he can play games on the way there. He decides to try High roll vs. Low roll again. He enjoys the game more now that he knows how to play. He is able to quickly decide between high and low and then choose a number. After he has been playing the game for a while, he gets bored and decides to play something else.

Sudoku

- People: Jim
Activities: Playing Sudoku
Context: Sunday afternoon
Technology: iPad

It is Sunday afternoon and Jim has asked for permission to play his iPad. He decides to try Sudoku. He has watched an older sibling play this game before, and he knows the basics of the gameplay. He views the tutorial and starts the game. At first he has trouble and uses a hint. After that he is able to complete the puzzle on his own.

- People: Jim
Activities: Playing Sudoku
Context: After school
Technology: iPad

Jim has been given permission to use his iPad. He decides to play Sudoku. His goal is to complete the puzzle without any help. It takes him a long time to solve the puzzle. When he has almost completed the puzzle, his mom tells him he needs to put the iPad away. He convinces his mom to let him finish the puzzle because he is worried that the game will not save his progress.

- People: Jim
Activities: Playing Sudoku
Context: At school
Technology: Laptop

Jim's teacher is allowing the class to play games on the school laptops. Jim decides to play Sudoku. He tells his friends about the game and they decide to play the game too. He teaches his friends how to play. They have a competition to see who can complete the puzzle first.

b. A college student

High roll vs. Low roll

- People: Rebecca
Activities: Playing High roll vs. Low roll
Context: Lunch break
Technology: Phone

Rebecca is in between classes and is taking her lunch break. She has an hour before her next class and she decides to play High roll vs. Low roll. She has never played this game before, but by viewing the tutorial, she quickly learns the gameplay. She enjoys this game because she likes probability and logic problems.

- People: Rebecca
Activities: Playing High roll vs. Low roll
Context: Evening hours, at home
Technology: Laptop

Rebecca is at home. She just finished her homework and has decided to play High roll vs. Low roll. She enjoys this game because its simplicity allows her to relax after her long day. She does not play long since it is late and she has to get up early for work.

- People: Rebecca
Activities: Playing High roll vs. Low roll
Context: Saturday afternoon
Technology: Phone

It is Saturday afternoon. Rebecca has just finished working on her homework and has decided to play games for a while. She selects High roll vs. Low roll. She selects low and chooses the number four. She rolls a three. She continues playing until she gets a call asking her if she can come to work.

Sudoku

- People: Rebecca
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: Phone

Rebecca just got home from work and has decided to play a game before starting her homework. She decides to play Sudoku because she likes logic games. She only has time to complete one puzzle because she has homework to do.

- People: Rebecca
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: Laptop

Rebecca is at home. She just finished her homework and has decided to play Sudoku. She gets bored of this game after a while and decides to play something else. She had been doing math homework all evening and did not feel like solving anymore logic problems.

- People: Rebecca
Activities: Playing Sudoku
Context: Sunday afternoon
Technology: Laptop

It is Sunday afternoon and Rebecca has some spare time. She decides to play Sudoku. She loads the application and selects Sudoku from the main menu. She times herself to see how fast she can complete a puzzle. She is able to quickly enter the correct numbers and retry if she entered a wrong number.

c. *Someone in their 30's*

High roll vs. Low roll

- People: John

Activities: Playing High roll vs. Low roll
Context: At work
Technology: Laptop

John is on a lunch break at work. He wants to play a game that is simple and entertaining. He decides to play High roll vs. Low roll. He has played similar games before, so he learns how to play this one quickly using the tutorial. Then he returns to the game menu and selects the play game option. He enjoyed this game. He said the game was easy to learn and the interface was simple and easy to use.

- People: John
Activities: Playing High roll vs. Low roll
Context: At home with family
Technology: Laptop

John is at home with his family. They want to play a game together. John suggests High roll vs. Low roll. They select the option to play the game. They play the game for a while, taking turns. Then they decide to play something else since this game is not designed for multiple players.

- People: John
Activities: Playing High roll vs. Low roll
Context: On a business trip
Technology: Phone

John is on a business trip. He just finished all of his meetings for the day, and he has some spare time. He decides to play High roll vs. low roll. He selects the option to play the game. He chooses high and picks a number, and then the random number from the roll is displayed. He is interrupted by a phone call from his family. After the call, he decides it is late and he needs to go to bed. John likes this game because when things come up, he can easily quit the game. He does not have to save any game progress because the rounds are so quick.

Sudoku

- People: John
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: Laptop

John is at home. While his kids are busy with homework, he decides to try a new game. He chooses to play Sudoku. He selects the option to view the tutorial and then returns to the menu to select the play game option. He has a difficult time

solving the puzzle. After a while, he gives up and decides to play a game with his kids since they are finished with their homework.

- People: John
Activities: Playing Sudoku
Context: On a business trip
Technology: Phone

John is on a business trip. He has some spare time between meetings, so he decides to play Sudoku. He selects the option to play the game. He begins entering numbers, trying to solve the puzzle. He is unable to finish the puzzle before his next meeting. After the meeting, John went to finish his puzzle to find his progress was not saved. John does not really mind restarting since he had lost his train of thought with the previous puzzle and would have had to remember where he left off.

- People: John
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: Desktop computer

John is teaching his nine year old son how to play Sudoku. He loads the application, selects Sudoku from the main menu, and selects the tutorial. When the application returns to the game menu, John selects the play game option. He lets his son try to solve the puzzle and helps him occasionally when his son is stuck.

d. A senior citizen

High roll vs. Low roll

- People: Mark
Activities: Playing High roll vs. Low roll
Context: Saturday morning
Technology: Phone

It is Saturday and Mark is at home. It is too cold to do anything outdoors, so Mark decides to try a new game. He loads the application and selects High roll vs. Low roll. On the game menu, he selects the tutorial. Once Mark is finished with the tutorial, he is taken back to the game menu where he selects to play the game. He was able to understand the instructions, so he quickly picks up on how to play.

- People: Mark
Activities: Playing High roll vs. Low roll
Context: Evening hours, at home

Technology: Laptop

Mark is home from work and is playing High roll vs. Low roll. He sat down to play without putting his glasses on. He cannot read well without his glasses. He accidentally selects high when he meant to select low. Because of this, he lost the round. Eventually he gets frustrated and gets up to get his glasses.

- People: Mark
Activities: Playing High roll vs. Low roll
Context: At work
Technology: Laptop

Mark is at work and has decided to play games on his lunch break. He selects the High roll vs. Low roll game from the main menu of the application. Then he selects the play game option. He plays multiple rounds. He likes how quick the rounds are, so he can quit whenever he needs to.

Sudoku

- People: Mark
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: Phone

Mark is home from work and is playing video games. He decided to play Sudoku. When he is in the middle of solving a puzzle, he gets a phone call from his wife telling him her car broke down and he needs to come pick her up. So he quits the game. When he gets back on, he finds that his progress was lost, so he closes the application.

- People: Mark
Activities: Playing Sudoku
Context: At work
Technology: Laptop

Mark is on lunch break at work. He opens the application and selects Sudoku. When his lunch break ends, he is in the middle of a puzzle. He has to close the application and lose his progress. He decides that when he is at work, he would rather play a game that does not take as long.

- People: Mark
Activities: Playing Sudoku
Context: Sunday afternoon
Technology: Phone

It is Sunday afternoon, and Mark has decided to play Sudoku. As Mark starts to play, he realizes that he needs his glasses. He tries to play a round without them. Several times he accidentally selected the wrong box or entered the wrong number. Eventually he gets up to get his glasses.

e. An elderly person

High roll vs. Low roll

- People: Rachel
Activities: Playing High roll vs. Low roll
Context: Middle of the day, at home
Technology: iPad

Since Rachel's health conditions have gotten worse, she stays at home more. She cannot do much physical activities anymore. She usually prefers playing card games, but since she is by herself most of the time, she wanted to find a single player game to play. She decided to try playing computer games. She tried playing High roll vs Low roll. At first she had trouble learning how to use the application. Once she learned how to use the application, she was able to play the game. She liked how she only had to enter one number or character at a time because she has limited use of her hands. She is unable to type fast and she does not want to play a game that requires her to type frequently.

- People: Rachel
Activities: Playing High roll vs. Low roll
Context: on the front porch
Technology: iPad

Rachel has been inside most of the time and has decided that she needs to spend more time outside. She is sitting on her front porch playing High roll vs. Low roll. She is having a difficult time seeing the screen even with the device's brightness turned up because of the sun and because she has poor eyesight. She decides to stop playing the game.

- People: Rachel
Activities: Playing High roll vs. Low roll
Context: Lying in bed
Technology: iPad

Rachel has been feeling worse, so she decided to stay in bed and play High roll vs. Low roll. She is having a difficult time reading the screen. She entered low

when she meant to enter high then she chose a number. When she was told she lost, she was confused. She ends up getting a headache, so she quits the game.

Sudoku

- People: Rachel
Activities: Playing Sudoku
Context: Morning hours, at home
Technology: iPad

Rachel enjoyed the High roll vs. Low roll game, so she decided to try Sudoku even though she does not like logic games very much. She viewed the tutorial, but she still did not know how to play. She tried playing the game but was unable to figure out how to play, so she quit the game.

- People: Rachel
Activities: Playing Sudoku
Context: In the car
Technology: iPad

Rachel is on her way to a family get together. Since she cannot drive, her daughter picked her up. On the way, Rachel's granddaughter showed her how to play Sudoku. They play the game together. Rachel was able to put the numbers in the correct spots with some help from her granddaughter.

- People: Rachel
Activities: Playing Sudoku
Context: Evening hours, at home
Technology: iPad

Rachel is at home and has decided to try Sudoku again. She has trouble solving the puzzle. She has no problems selecting the box she wants to fill in. However, it is difficult for her to figure out which number she has to place in a specific box. After a great deal of trial and error, she completes the puzzle. She finds the Sudoku game to be too hard for her, so she decides she does not want to play it again.

IV. Interface Design

This section shows sketches for the possible interface for the application. It shows what the screen will look like when the user accesses the game, chooses a game, and plays a game.

a. Accessing the Game

Figure 1 shows the main menu for the 2 in 1 Numbers application. The user is given the options to choose a game or close the application.

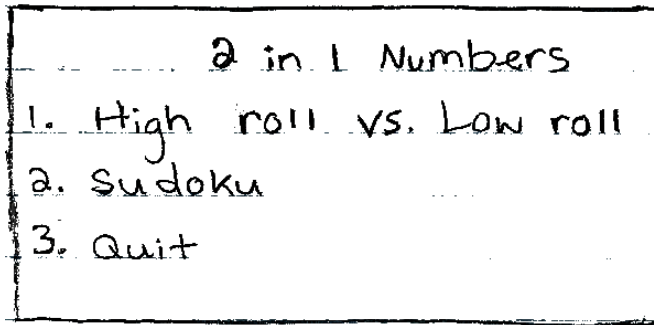


Figure 1. Main Menu

b. Choosing a Game

Figure 2 shows the result of selecting the second option from the application's main menu shown in figure 1. Here the user is given the options to either play the game, view the tutorial, or return to the main menu.

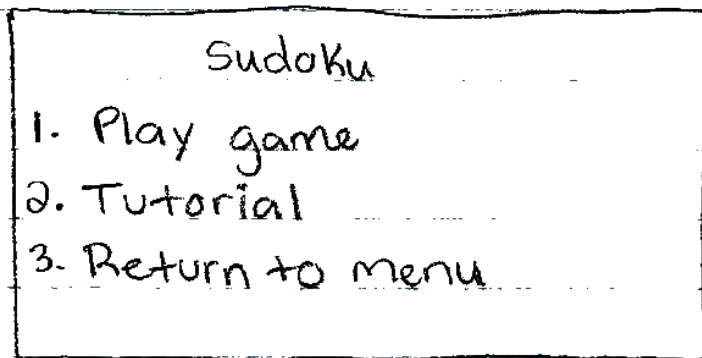


Figure 2. Sudoku Game Menu

Figure 3 shows the result of selecting the first option from the application's main menu shown in figure 1. Here the user is also given the options to either play the game, view the tutorial, or return to the main menu.

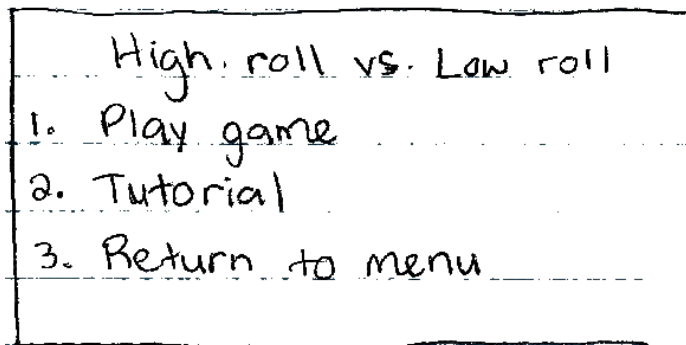


Figure 3. High roll vs. Low roll Game Menu

c. Playing a Game

Figure 4 shows an example of a Sudoku game. The user is able to select a number and select the place they want to insert the number into.

Sudoku				
*	*	3	.	1
1	*	2	*	
3	*	*	*	
4	2	*	*	
Enter coordinates: 1,1				
Enter a number 1-4: 2				
2	*	3	.	1
1	*	2	*	
3	*	*	*	
4	2	*	*	

Figure 4. Playing Sudoku 1

Figure 5 shows another example of a Sudoku game. If the user enters the wrong number, they are given an opportunity to retry.

Sudoku				
*	*	2	*	
1	*	4	*	
*	3	*	*	
*	*	*	2	
Enter coordinates: 1,5				
Invalid. Enter coordinates: 1,4				
Enter a number 1-4: 6				
Invalid. Enter a number 1-4: 4				

Figure 5. Playing Sudoku 2

Figure 6 shows an example of a High roll vs. Low roll game. The user is able to select the roll they want to bet on and select a number.

High roll vs. Low roll

Do you want to bet on a high or low roll (H/L)? L

Enter a number 1-8: 3

Die: 6

You lose.

Do you want to play again (Y/N)? N

1. Play game
2. Tutorial
3. Return to menu

Figure 6. Playing High roll vs. Low roll 1

Figure 7 shows an example of a High roll vs. Low roll game. When invalid data is entered, the user is asked to re-enter the data.

High roll vs. Low roll

Do you want to bet on a high or low roll (H/L)? G

Enter H or L: H

Enter a number 1-8: 9

Invalid. Enter a number 1-8: 4

Die: 7

You win!

Do you want to play again (Y/N)? Y

Do you want to bet on a high or low roll (H/L)?

Figure 7. Playing High roll vs. Low roll 2

V. HTA Diagram

This section shows the HTA diagram for the 2 in 1 Numbers application. The HTA diagram shows the tasks that the user can complete when using the application. The diagram is shown in figure 1 and figure 2.

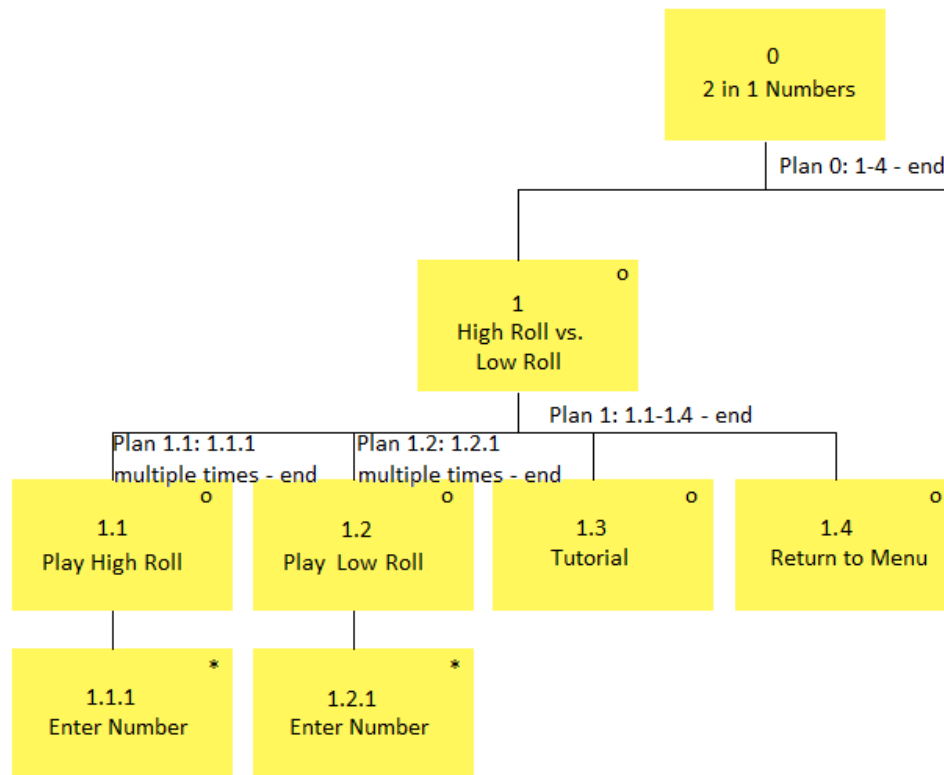


Figure 8. HTA Diagram Part 1

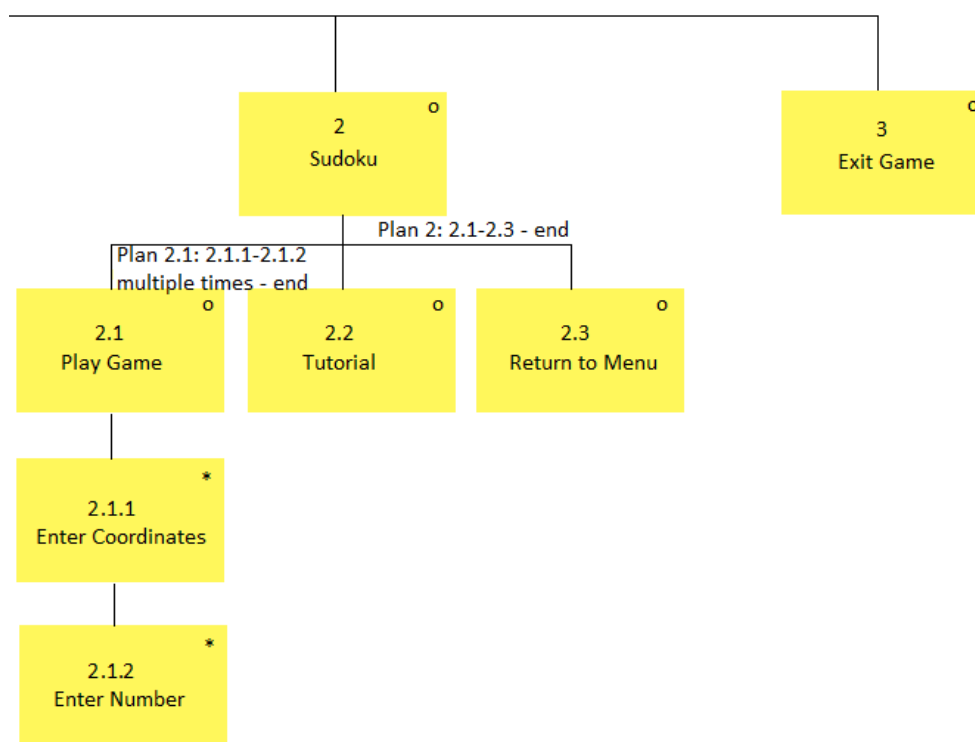


Figure 9. HTA Diagram Part 2

VI. Planned Steps

This section describes each of the planned steps from the HTA diagram in the previous section. With each step, there are multiple tasks the user can complete. The resulting actions from these tasks are also documented.

Plan 0: 1-3 – end. Select main menu option 1-3.

- The user selects option 1. Go to High Roll vs. Low Roll
- The user selects option 2. Go to Sudoku
- The user selects option 3. The game ends
- If anything else is entered, an error message is displayed and the user is allowed to re-enter.

Plan 1:1.1-1.4 – end. Select High roll vs. Low roll menu option 1.1-1.4.

- The user selects option 1.1. The High roll game starts.
- The user selects option 1.2. The Low roll game starts
- The user selects option 1.3. The game rules are displayed.
- The user selects option 1.4. The application returns to the main menu.
- If anything else is entered, an error message is displayed and the user is allowed to re-enter.

Plan 2:2.1-2.3 – end. Select Sudoku menu option 2.1-2.3

- The user selects option 2.1. The Sudoku game starts.
- The user selects option 2.2. The game rules are displayed.
- The user selects option 2.3. The application returns to the main menu.
- If anything else is entered, an error message is displayed and the user is allowed to re-enter.

Plan 1.1:1.1.1 multiple times – end. Play High roll.

- The user enters a number 1-8 for the High roll game.
- If the input is invalid, an error message is displayed and the user is allowed to re-enter.
- They repeat this until they want to end the game.

Plan 1.2:1.2.1 multiple times – end. Play Low roll.

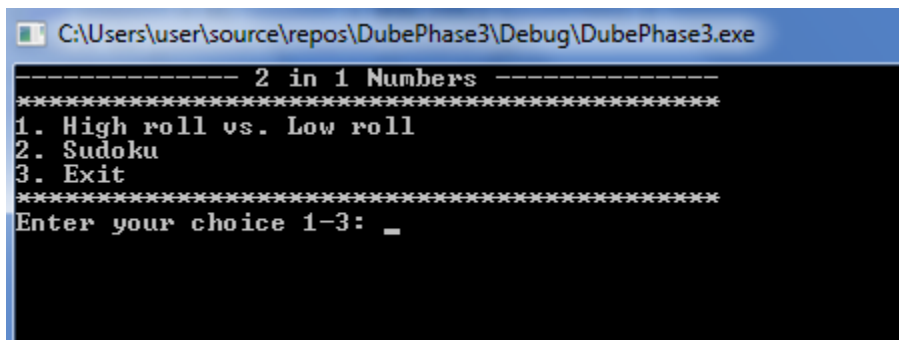
- The user enters a number 1-8 for the Low roll game.
- If the input is invalid, an error message is displayed and the user is allowed to re-enter.
- They repeat this until they want to end the game.

Plan 2.1:2.1.1-2.1.2 multiple times – end. Play Sudoku.

- The user enters coordinates.
- The user enters a number 1-4.
- If any of the input is invalid, an error message is displayed and the user is allowed to re-enter.
- They repeat this until they want to end the game.

VII. Game Functionality

This section goes over the functionality of the 2 in 1 Numbers application. Figure 10 shows the main menu of the 2 in 1 Numbers application. The user is given three options: they can play either of the games or exit the application.



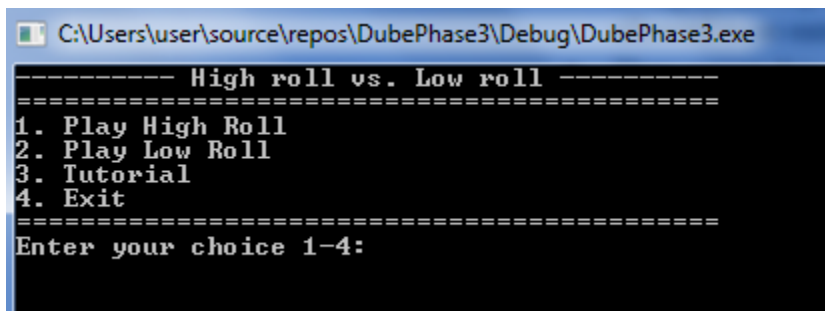
```

C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- 2 in 1 Numbers -----
*****
1. High roll vs. Low roll
2. Sudoku
3. Exit
*****
Enter your choice 1-3: _

```

Figure 10. The Main Menu

Figure 11 shows the High roll versus Low roll game menu. The user can play High roll or Low roll, or view the tutorial, or exit the game.



```

C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- High roll vs. Low roll -----
=====
1. Play High Roll
2. Play Low Roll
3. Tutorial
4. Exit
=====
Enter your choice 1-4:

```

Figure 11. High roll versus Low roll Menu

In figure 12, the user has chosen the “Tutorial” option. This option displays the game rules.


```
C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- High roll vs. Low roll -----
=====
1. Play High Roll
2. Play Low Roll
3. Tutorial
4. Exit
=====
Enter your choice 1-4: 2
Enter a number 1-8: 3
Press any key to continue . . .
----
|***|
|** |
|___|
|___|
Die: 5
Your Number: 3
You lose.
Press any key to continue . . .
```

Figure 14. Play Low Roll

The user has selected option 4, “Exit,” and has returned to the main menu where they selected Sudoku. Figure 15 shows that the user has selected the “Tutorial” option from the game menu. The Sudoku game rules are displayed.

```
C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- Sudoku -----
=====
1. Play Sudoku
2. Tutorial
3. Return to Menu
=====
Enter your choice 1-3: 2
---- Tutorial ----
Every square has to contain one number
1 through 4 are the only numbers that can be used
Every 2x2 box must have every number 1 to 4 once
Every column must have each number from 1 to 4 once
Each row must have each number from 1 to 4 once

When the puzzle is solved, every row, column, and 2x2
box will have every number from 1 to 4 exactly once.
Press any key to continue . . .
```

Figure 15. Sudoku Tutorial

In figure 16, the user has selected the option “Play Sudoku.” The initial Sudoku board is shown in the figure.

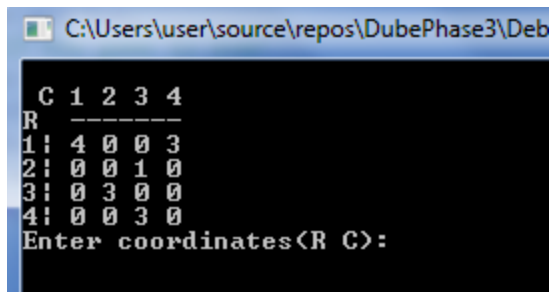


Figure 16. Play Sudoku

In figure 17, the user has completed the Sudoku puzzle. The Sudoku array is checked to make sure it is accurate.

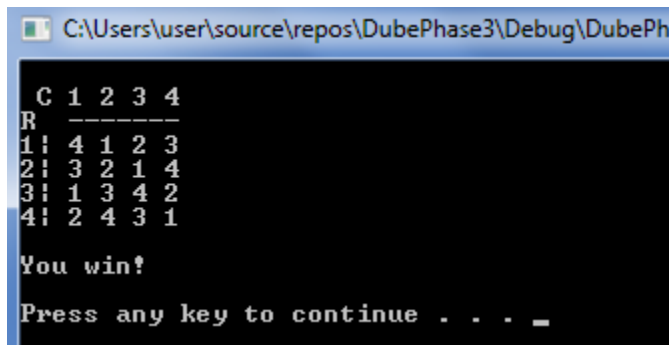


Figure 17. Play Sudoku 2

Figure 18 shows the user entering an invalid menu choice. When a user presses a key to continue, the menu will be redisplayed.

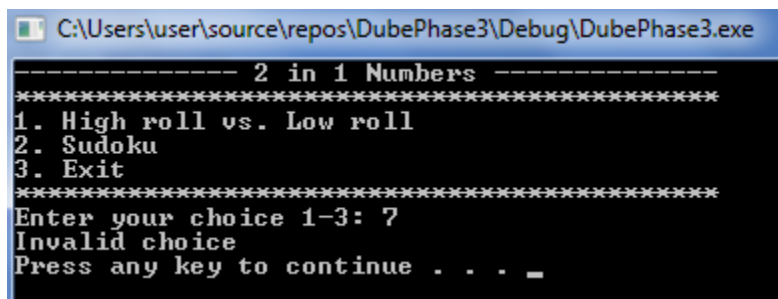


Figure 18. Menu Input Validation

In figure 19, the user has entered an invalid number during a game of High roll. They are given the opportunity to re-enter.

```
C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- High roll vs. Low roll -----
=====
1. Play High Roll
2. Play Low Roll
3. Tutorial
4. Exit
=====
Enter your choice 1-4: 1
Enter a number 1-8: 9
Enter a number 1-8: _
```

Figure 19. High roll versus Low roll Input Validation

In figure 20, the user was able to re-enter the coordinates and the number to be inserted in the array for Sudoku. First they entered coordinates that were out of range, and then they entered coordinates that were already taken.

```
C:\Users\user\source\repos\DubePhase3\Debug
C 1 2 3 4
R -----
1: 3 2 0 0
2: 0 0 0 2
3: 0 4 0 0
4: 0 0 2 0
Enter coordinates(R C): 5 5
Enter coordinates(R C): 1 1
Enter coordinates(R C): 1 3
Enter a number 1-4: 5
Enter a number 1-4: 1
```

Figure 20. Sudoku Input Validation

VIII. Questionnaire and Interviews

This section includes the questionnaires and interviews. The preliminary data is addressed first, including the participants and the plan for developing the questionnaire and conducting the interviews. Lastly the results are included and explained.

a. Participants

The participants are made up of three children and three adults.

1. Nathan
2. Matthew S.
3. Sarah
4. Laura
5. Matthew W.
6. Dana

b. Representative tasks

1. Choosing an item from the menu.
2. Re-entering data when the first entry is invalid.
3. Going back and forth between games.
4. Playing each game.
5. Entering coordinates on Sudoku.
6. Entering numbers in the correct range for the menus and the games.

c. Measurements

The user can rate their performance of the different tasks using a rating scale, like the Likert scale. With the Likert scale, the user will choose from five options to determine how much they agree or disagree with a statement. The questionnaire consists of statements where the user will rate themselves with the Likert scale and two open-ended questions to get user opinions. The measurements to be made should include the following: time taken to learn how to use the application and the efficiency of using the application.

d. Outline Plan

1. Develop a Questionnaire
 - i. Gather information about the user's problems, difficulty level of learning the interface, design recommendations and additional information.
2. Administer the questionnaire to six individuals
 - i. Have the participants fill out the questionnaire.
 - ii. Interview these individuals to gather further information.
3. Record and explain the results
 - i. Explain each question and summarize the participants' responses.

e. Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☐
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☐
3. The menus were easy to understand.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐

6. Overall the application was easy to learn and use.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐

7. The layout of the Sudoku board was easy to understand.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐

8. How to enter coordinates for the Sudoku board was clear.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐

9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐

10. List one or more things that you did not like about the application?

11. Additional comments

f. Results

This section goes over the results of the Questionnaire and the participants' responses from the interviews. The completed questionnaires are included in Appendix I.

Questions 1-2 were included to determine if the user already knew how to play the games. Based on the results shown in figure 21, the majority of the participants did not know how to play either game.

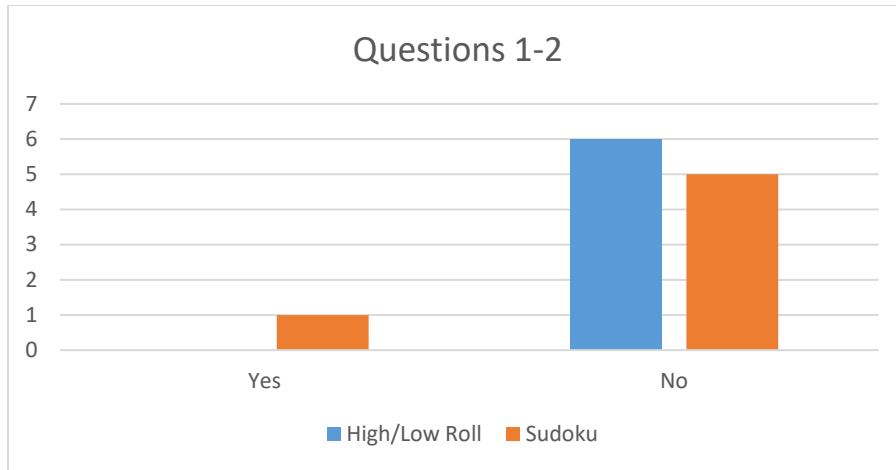


Figure 21. Questions 1-2.

Questions 3-6 were asked to determine how easy it was for user to learn the interface. The results of question three are shown in figure 22. The majority of the participants said the menus were clear and easy to use. One participant had trouble with the menus. He said it took him a while to figure out what he needed to do.

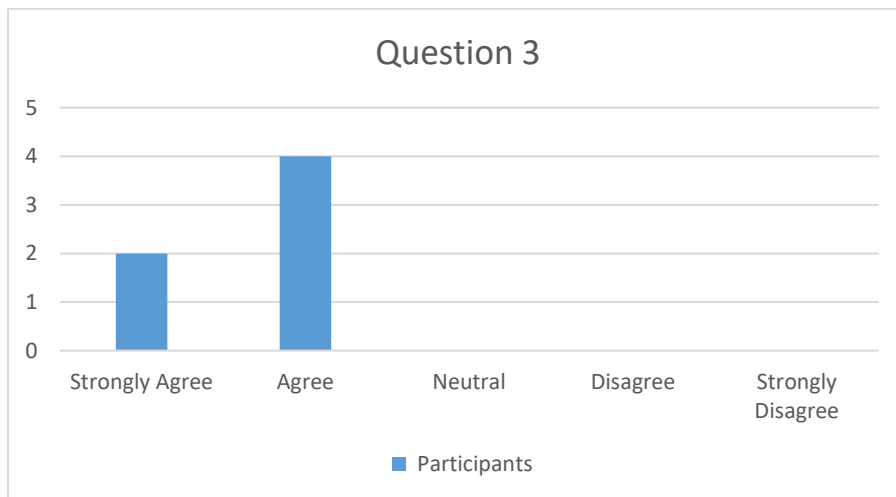


Figure 22. Question 3

The results of question four are shown in figure 23. The participants all said navigating around the application was simple. The participant who had trouble with the menus said navigating the game was easy once he learned how to use the menus. One participant mentioned that they did not like how they had to finish a Sudoku game to return to the menu.

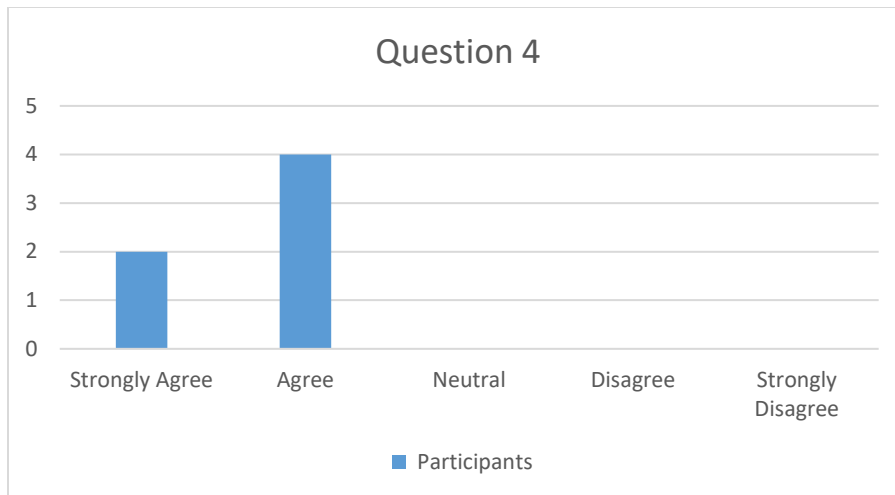


Figure 23. Question 4

Figure 24 shows the results for question five. Three participants had some trouble with the number ranges. They all said that it was not clear that they needed to press the enter key. Several of the participants said they thought the question was only referring to choosing a number. Because of this, two of the participants who had trouble with the number ranges selected strongly agree. The other participants said they had no problems using the number ranges after I explained the question.

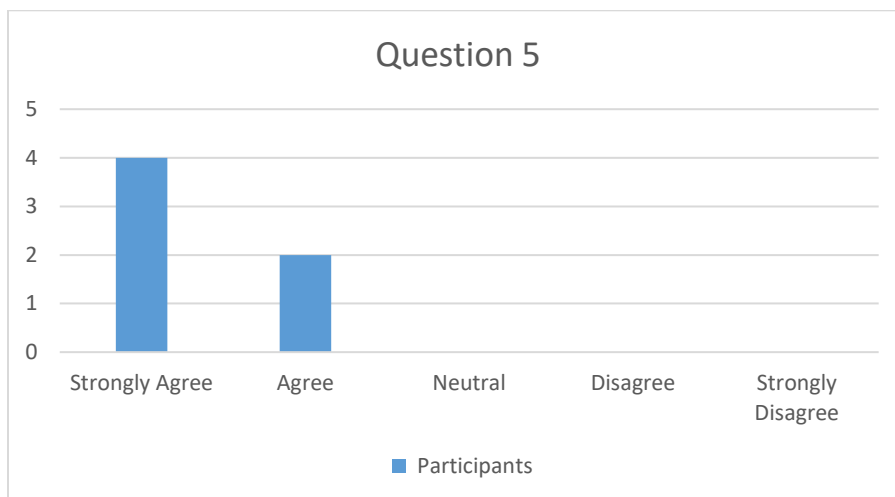


Figure 24. Question 5

Figure 25 shows the results of question six. Question six was included to get the participants to rate their experience with the application. The participant who selected strongly agree said the application was easy to use and the only problems she had were because she did not know how to play High roll vs. Low roll and it had been a while since the last time she had played Sudoku; she had to spend time figuring out the gameplay. Another participant also said they had some trouble learning the gameplay. Three of the participants specifically said Sudoku was confusing. One participant said the

application was not easy to use compared to a graphical program, but as a console application it was easy.

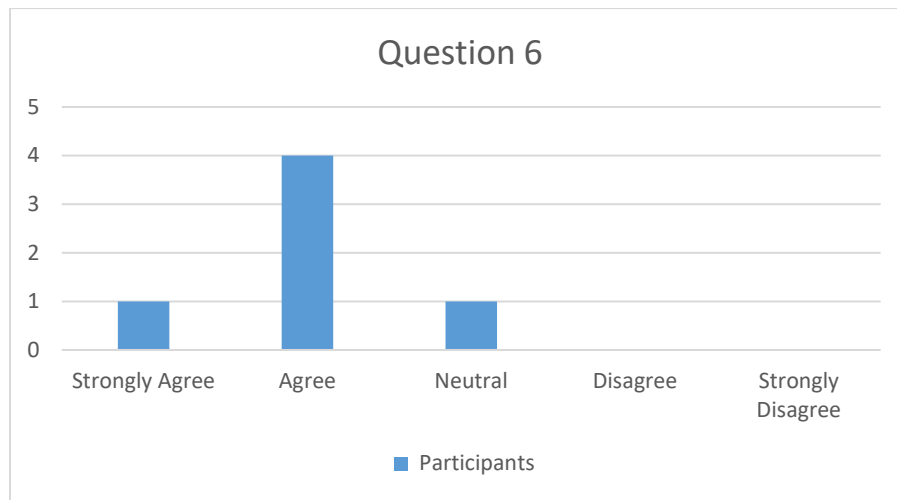


Figure 25. Question 6

Questions 7-9 were included to determine if the user had any difficulty playing the different games. The results for question seven are shown in figure 26. The five participants who have not played Sudoku said they had trouble with the layout of the board because even after reading the instructions, they still had trouble understanding the game. Several of the participants mentioned that the Sudoku board was hard to understand because it was not very graphical. The participant who has played Sudoku before said she was confused at first because she was expecting to see a nine by nine board.

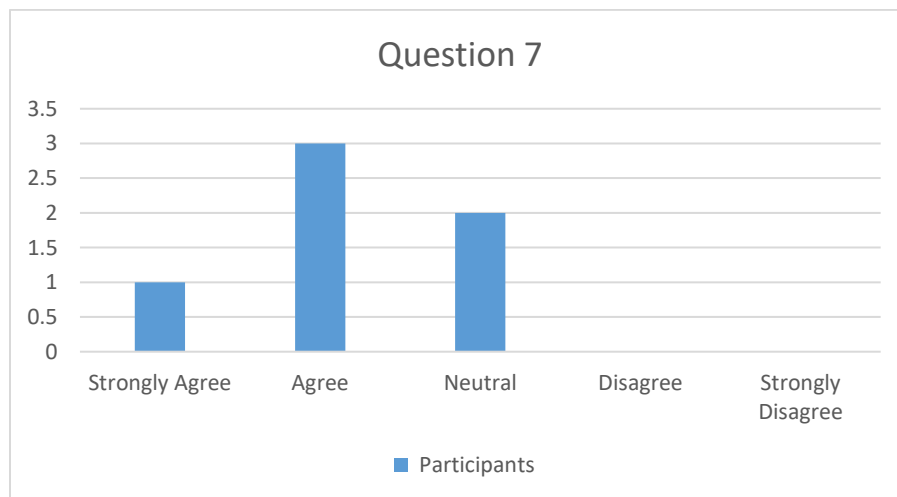


Figure 26. Question 7

Figure 27 shows the results for question eight. Everyone mentioned that they had some problem with the rows and the columns. One participant said she kept getting them

backwards. She was thinking of it as x and y, where the x values are the numbers across the top and the y values are down the side. So she thought it made more sense to enter it in as C followed by R, instead of R followed by C. One participant had trouble with the coordinates because he did not see R and C in the image at first. Two of the participants said they could not understand what R and C meant; they did not realize that R went with the set of numbers down the side and C went with the set of numbers across the top. One participant said the statement “Enter coordinates(R C)” was confusing; he did not know if he needed to include the parenthesis in his response. The last participant said the coordinates were easy; it just took her some time to figure it out.

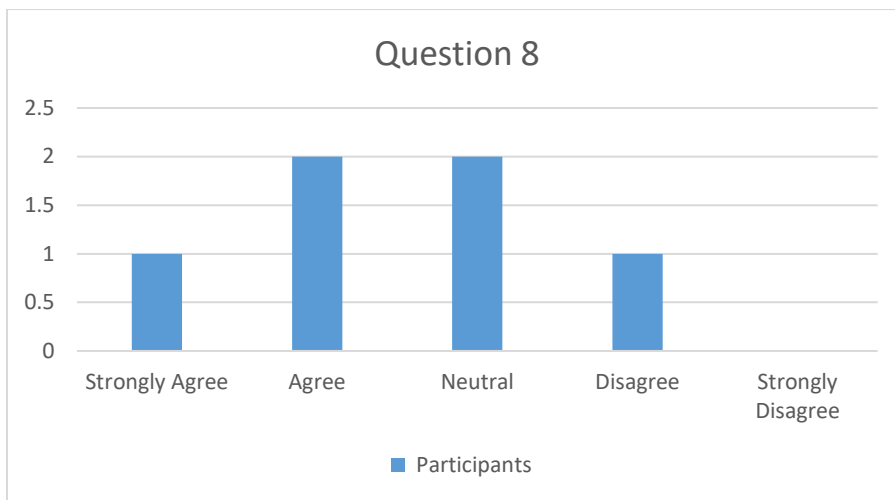


Figure 27. Question 8

The results for question nine are shown in figure 28. Two participants thought High roll vs. Low roll was easy, and they learned the difference quickly. The other participants said it took them a while to learn the difference between High roll and Low roll.

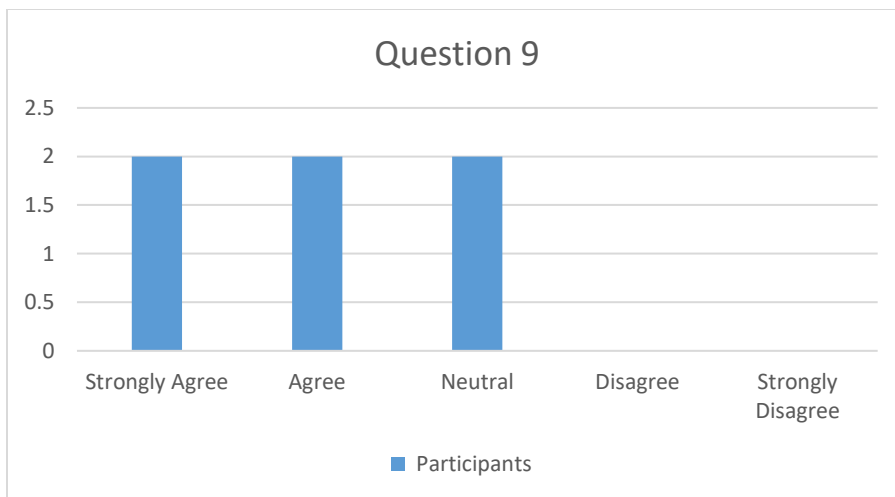


Figure 28. Question 9

Questions 10-11 were included to get user opinions about the application. Two participants mentioned that they did not like High roll vs. Low roll because it was difficult to remember the difference between the two. One participant mentioned that the tutorials could be improved by adding visual instructions. Two participants said the Sudoku game was confusing and they needed more instructions. One participant mentioned that games usually have music and the application could be improved by adding music.

IX. Application Modifications

This section summarizes the results of the questionnaire and discusses modifications that could be made to the application.

a. Results

Table 1 shows the overall results of the questionnaire. Table 2 shows the results for ages seventeen and under and table 3 shows the results for ages eighteen and up. The tables show that the participants mostly had difficulty learning how to play the games and learning how to use the interface. The participants specifically had trouble with the layout of the Sudoku board.

Table 1
Questionnaire Results

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Question 3	33.33%	66.67%	0%	0%	0%
Question 4	33.33%	66.67%	0%	0%	0%
Question 5	66.67%	33.33%	0%	0%	0%
Question 6	16.67%	66.67%	16.67%	0%	0%
Question 7	16.67%	50.0%	33.33%	0%	0%
Question 8	16.67%	33.33%	33.33%	16.67%	0%
Question 9	33.33%	33.33%	33.33%	0%	0%

Table 2
Questionnaire Results 0-17 Years Old

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Question 3	33.33%	66.67%	0%	0%	0%
Question 4	33.33%	66.67%	0%	0%	0%
Question 5	66.67%	33.33%	0%	0%	0%
Question 6	0%	100.00%	0%	0%	0%

Question 7	33.33%	33.33%	33.33%	0%	0%
Question 8	0%	66.67%	0%	33.33%	0%
Question 9	33.33%	33.33%	33.33%	0%	0%

Table 3
Questionnaire Results 18+ Years Old

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Question 3	33.33%	66.67%	0%	0%	0%
Question 4	33.33%	66.67%	0%	0%	0%
Question 5	66.67%	33.33%	0%	0%	0%
Question 6	33.33%	33.33%	33.33%	0%	0%
Question 7	0%	66.67%	33.33%	0%	0%
Question 8	33.33%	0%	66.67%	0%	0%
Question 9	33.33%	33.33%	33.33%	0%	0%

b. Modifications

This section includes modifications that can be made to the application and their possible implementations.

- The tutorials are not very detailed. The tutorials can be improved by adding more information and an example of a game. The Sudoku tutorial could explain the layout of the Sudoku board, including how the rows and columns are represented as R and C.
- Currently, if the user starts a Sudoku game, they have to finish the game before they can return to the menu. One modification that can be made is providing a way for the user to return to the menu at any point in the game.
- The layout of the Sudoku board was not very clear. This could be fixed by making the tutorial more detailed. The tutorial could explain the layout of the board.

Figure 29 shows how the Sudoku tutorial could be modified and figure 30 shows how the High roll vs. Low roll tutorial could be modified.

```

C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- Sudoku -----
=====
1. Play Sudoku
2. Tutorial
3. Return to Menu
=====
Enter your choice 1-3: 2

---- Tutorial ----
Every square has to contain one number
1 through 4 are the only numbers that can be used
Every 2x2 box must have every number 1 to 4 once
Every column must have each number from 1 to 4 once
Each row must have each number from 1 to 4 once

When the puzzle is solved, every row, column, and 2x2
box will have every number from 1 to 4 exactly once.

  C 1 2 3 4
R -----
1: 4 1 2 3
2: 3 2 1 4
3: 2 3 4 1
4: 1 4 3 2
Enter coordinates(R C):1 2
R stands for rows. The rows are the numbers down
the side.
C stands for columns. The columns are the numbers
across the top.
Press any key to continue . . .

```

Figure 29. Sudoku Tutorial Changes.

```

C:\Users\user\source\repos\DubePhase3\Debug\DubePhase3.exe
----- High roll vs. Low roll -----
=====
1. Play High Roll
2. Play Low Roll
3. Tutorial
4. Exit
=====
Enter your choice 1-4: 3

---- Tutorial ----
High Roll
If the user chooses a number higher than what they roll,
they lose. The pick was low.
If the user chooses a number lower than what they
roll they win. The pick was high.
Enter a number 1-8: 4
Press any key to continue . . .

***
|
|
|
|
---
Die: 3
Your Number: 4
You lose.

Low Roll
If the user chooses a number lower than what they roll,
they lose. The pick was high.
If the user chooses a number higher than what they
roll they win. The pick was low.
Enter a number 1-8: 4
Press any key to continue . . .

***
|
|
|
|
---
Die: 3
Your Number: 4
You win.

Press any key to continue . . .

```


Figure 30. High roll vs. Low roll Tutorial Changes.

c. *Questionnaire Design*

I would leave the questionnaire as it is and re-administer it. If the questionnaire is unaltered, then the results can be compared to the previous results to see if the modifications improved the interface. This would be helpful in seeing the impact the changes had on the overall design of the application. Only minor changes are being made to existing components of the application; nothing major is being added, so there is no need to change the questionnaire. The only thing that may need to be modified on the questionnaire is the open-ended question (question 10). A few of the participants said they did not really know how to answer that question. The question should probably be removed before re-administering the questionnaire.

X. References

[1] “How to Play Sudoku for Dummies – Every Rule Explained – Mastering Sudoku.”
<https://masteringsudoku.com/sudoku-rules-beginners/> (accessed Oct. 22, 2021).

Appendix I.

Questionnaires

The figures below are the questionnaires that have been completed by the participants.

Nathan

2 in 1 Numbers Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☒
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☒
3. The menus were easy to understand.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☒ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
10. List one or more things that you did not like about the application?
I don't like Sudoku

11. Additional comments

Figure I-1. Questionnaire 1

Matthew S.

2 in 1 Numbers Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☒
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☒
3. The menus were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
10. List one or more things that you did not like about the application?

The sudoku game was confusing.

11. Additional comments

Figure I-2. Questionnaire 2

Sarah

2 in 1 Numbers Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☒
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☒
3. The menus were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
10. List one or more things that you did not like about the application?

highroll and low roll

11. Additional comments

I kept winning on sudoku

Figure I-3. Questionnaire 3

2 in 1 Numbers Questionnaire - Laura

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☐
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ **No** ☐
3. The menus were easy to understand.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☐ **Agree** ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
10. List one or more things that you did not like about the application?
No music

11. Additional comments
Sudoku was a 4*4 instead of the full size of the normal game

Figure I-4. Questionnaire 4

Matthew W.

2 in 1 Numbers Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☒
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☒
3. The menus were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
10. List one or more things that you did not like about the application?
I need more visual instructions

11. Additional comments
Thanks

Figure I-5. Questionnaire 5

Dana

2 in 1 Numbers Questionnaire

1. Before playing this game, I knew how to play Sudoku.
Yes ☐ No ☒
2. Before playing this game, I knew how to play High roll vs. Low roll.
Yes ☐ No ☒
3. The menus were easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
4. It was easy to go back and forth between the different games.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
5. The number ranges used in the application (like for selecting a menu item) were easy to understand.
Strongly agree ☒ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree ☐
6. Overall the application was easy to learn and use.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
7. The layout of the Sudoku board was easy to understand.
Strongly agree ☐ Agree ☒ Neutral ☐ Disagree ☐ Strongly disagree ☐
8. How to enter coordinates for the Sudoku board was clear.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐
9. The difference between High roll and Low roll was easy to learn through the tutorial and by playing the games.
Strongly agree ☐ Agree ☐ Neutral ☒ Disagree ☐ Strongly disagree ☐

10. List one or more things that you did not like about the application?

I didn't like the roll game, only because I didn't understand how to play!

11. Additional comments

Figure I-6. Questionnaire 6