Team Biohazard

CSSE 371 Milestone Five

Vismay Modi,
Chris Hoorn,
Spencer Murphy,
Zhengyu(Daniel) Qin

Date	Version	What's new
10/30/12	1.0(Baselined version)	Milestones 1-4
11/2/12	2.0	Content for PM
11/6/12	3.0 (Final version)	Appendices, fixes, field studies

Table of Contents

1. Executive Summary

This document will elicit further details about the development of the BioHazard project, the game BioPioneer. Our project will be a fun and educational introduction for young adults into the diverse field of Synthetic Biology. Most tablet games currently do not present the users with the unique opportunity to learn something while playing, however BioPioneer would be an ideal candidate to meet that challenge. Through its innovative in-game tutorials and its detailed Learning Center, BioPioneer retains the fun of game-play and combines it with multiple styles of education in order to meet the varied needs of our users. This milestone is the final milestone in the project and it will document the results and analysis of the usability tests of our prototype. It will go over our interface design and testing methods.

2. Introduction

In the last milestone, The team set up processes to handle changes in requirements and codes. Also the team discussed test cases tailored to our use cases and quality attributes from previous Milestones.This is the last milestone in this quarter, in this milestone, we will summarise what we have achieved so far, and discuss further in usability test.

3. Project Content

3.1 Client Background:

Our client is Mr. Ben Deschaine, a current Rose-Hulman senior majoring in Biomedical Engineering and Resident Advisor in the Apartments West Residence Hall. Over the summer of 2012, Ben designed and created the Biopioneer board game as an entry in the IGEM competition. At first the idea of a board game was presented as a joke. That was until Ben actually went to his room and made the board game. After several weeks of tweaking, the game became adequately fair to be played by consumers. It was at that point Ben decided to commercialize his game by selling it as a tablet application. In order to do this, he approached Dr. Chenoweth and asked the app to be designed as part of the CS/SE Junior project.

3.2 Current System:

Currently, BioPioneer is a board game that is still in beta testing. The current board and pieces are playable, but they are all hand drawn cards and handmade pieces. A single 6-sided die is used for movement, and a rulebook is also available. In its current state the game can take up a lot of space due to the amount of pieces and cards. Currently, there is only one set that has all of the pieces. A printed board and set of cards and pieces are also being made in order to give the board game a more professional look. As this is a new game that Ben and the IGEM group have made, there is no existing software system to integrate with.

3.3 User/Stakeholder Description:

3.3.1 User/Stakeholder Profiles

All users will be presented with the same GUI and feature options.

End User:
Student - Our project will be geared primarily toward this user profile. The base user of the application is expected to be students or others with interest in learning synthetic biology interactively. To make the game easier for these users, there will be helpful tutorials and hints throughout. In addition, educational information about game elements, such as the equipment and papers, is to be included in the final version of the game for those interested in expanding the learning experience. The major issue we face with this demographic is creating a game that teaches students while they play. This user would consider a successful game to be one that is easy to learn, fun to play, and aids in learning synthetic biology.

The environment for the student user will be a classroom setting. Students will make use of the game's local 1-4 multiplayer capabilities on Apple iPads. Students may also make use of single player AI if the game is integrated as part of a homework assignment. The games play time of an hour can easily fit into a block scheduled class session.

Gamer - While it is an educational game, Biopioneer has the potential to attract those users who are looking for a fun way to pass the time. These users may have limited knowledge of the world of synthetic biology. The problem we face here is making a game that users will find fun and attractive enough to enjoy playing without feeling bored or intimidated by the amount of educational information. This user would consider a successful game to be one that is pretty to look at and fun to play.

Like students, the gamer user group will play the game in both competitive multiplayer and challenging single player settings. The major difference in environmental concerns for this user group is in the location of play. Users will be interested in playing not only in a home setting, but also while travelling. The game's quick play mode will allow games to be completed during transit.

Knowledgeable Student/Biologist - This profile describes those users who already have a deeper understanding of synthetic biology. For them, the game should represent a fun and accurate foray into their area of interest. Our major concern when accounting for this group will be making a game that stays true to the field of synthetic biology. Inaccuracies in the game will make it appear juvenile and those associated will lose credibility. This user will define a successful game as one that is fun to play and accurately represents the field of synthetic biology.

The environment for this user group is a combination of the two above, though these users may also assess the application from a critic standpoint.

Teacher: One intended use for the Biopioneer application is classroom education. While students will be the users of the application, teachers will act as facilitators in iPad driven classes. Teachers, even more than the students, will be concerned with the educational merit of the game. They will view a successful game as one that engages students' interest and teaches them about synthetic biology.

The teacher stakeholder will be involved in classroom sessions. They will function as guides and facilitators, rather than players.

Client/Owner: Our client intends to own the rights to the application. As the original creator of the table version of the game, he is very knowledgeable of its details. His main focus is on addressing the needs of the three user profiles listed above. His definition of a successful game is one that accounts for the needs of all potential users while adhering to the original format of the board game as he designed it.

The client is able to view the application from an overseer's standpoint.
He will review the application within a testing environment acting as a user and critic.

3.3.2 Key Needs

Relevant Stakeholder: End User, Client
Need: There is only one tangible board game which affects anyone who uses the game or could play the game and results in only one group being able to play at a time.
Current Solution: It is currently an actual board game with only a single set of pieces, die, and paper cards.
Possible Solution: We will develop the game for IOS devices particularly iPad.This would allow the game to be played anywhere with multiple people playing at once.

Relevant Stakeholder: Teacher, Client
Need: The game doesn't have direct educational explanations which affects students, teachers, and anyone who plays the game and results in them not learning as much from the game as originally intended.
Current Solution: The game uses scientific practices and terms which can be looked up.
Possible Solution: Provide description and teaching points for the processes and items used in the game by clicking on them. This would make the game much more educational as the players could better understand the tools they were using and learn more about synthetic biology in general.

Relevant Stakeholder: End User
Need: The board has many pieces that clutter the playing area which affects anyone playing the game and results in a large area needed to play and many pieces that must be accounted for.
Current Solution: There is currently no solution.
Possible Solution: Create a easy to use interface for the application that keeps the game organized and the pieces from being lost or accidentally moved. This allows for the game to be played anywhere without pieces that could be misplaced.

Relevant Stakeholder: End User
Need: Often there is no one to play with which affects anyone that wants to play the game but can't find someone to play against and results in these people not playing or having to wait for other playing to play with them.
Current Solution: There is no current solution other than finding more people to play with them.
Possible Solution: Develop AI so that a person can play by themselves. This would allow people to play whenever they want without having to search for others to play.

3.3.3 Alternatives and Competition

Textbooks & Web Reference:

Those users interested in the educational merits of the game may consider alternatives such as biology textbooks, websites, lab exercises, and encyclopedias. The game is designed to be an introduction to Synthetic Biology, from which students can expand their knowledge through more traditional learning practices.

Competing Board Game Apps:

Among those users seeking a fun board game app, there are many competing alternatives, such as Words with friends, Dice with buddies, and many others. Without an engaging user experience and educational base, BioPioneer may be facing an ominous array of competitors.

Original Board Game:

Another alternative to purchasing our application is to simply purchase a copy of the original board game. This option may be attractive to customers who do not have access to a mobile device the application runs on.

3.4 Product Overview:

3.4.1 Product Perspective

This product is completely independent of all other applications on the market. We are making a mobile version of a board game that will be played on iPads by our target customers, who, according to the client, are students and young adults. It's purpose is to interest students or other users in synthetic biology and bioengineering as career choices.The product, BioPioneer, is likely to provide a very general understanding of the equipment and methods used in synthetic biology while giving the users a fun platform to learn from. Our product stands apart from other games on the market because it is both a multiplayer and single player game that mixes education with fun.

3.4.2 Elevator Statement

As part of our CSSE Junior project we will be designing and building an application for a synthetic biology board game called BioPioneer. BioPioneer is a game designed by a Rose-Hulman senior while working on a project for the IGEM competition. The game, as an app, will

be more fun to play, interactive and mildly educational for our target audience, students and young adults.

3.4.3 Summary of Capabilities

No	Customer benefit	Supporting Feature
1	Players can learn synthetic biology by playing the game	**Educational Pop-ups**
2	Players can meet other players	**Multiplayer Option**
3	Players can experience different content of game every time	**Random Initialization of Games**

3.4.4 Assumptions and Dependencies

1. Students will have access to iPads
2. All current iPads will be updated to iOS6
3. Most users of the product will use it as a multiplayer game rather than single player.

3.4.5 Rough Estimate of the Cost

Since Apple charges money for iOS developer accounts, and at least we should have two people work on the project, the cost is 99*2 =180(USD). Board game printing fee: 30(USD)

This is not a simple game, as we assumed, the project will go through from fall quarter to spring quarter. Approximately, it will have take up to 200 hours in coding and optimizing time.

3.5 Features

Touch User Interface
ID: 1

Status: Approved

Priority: Critical

Effort: Built- Into Hardware

Risk: Medium

Stability: High

Reason: Since this game is going to be played on portable device as a native application, it will automatically have a touch interface feature.

Background Music

ID: 2
Status: Approved
Priority: Useful
Effort: Low
Risk: Low
Stability: High
Reason: Most modern games have background music that is looped as the game is played. This feature can be turned off or on at the convenience of the user.

Themes For Each Player
ID: 3
Status: Approved
Priority: Useful
Effort: Medium
Risk: Low
Stability: High
Reason: It is import for a user to be able to customize their game play to their personality. We will offer minimal, but essential features such as choice of color and shape to the user.

Multiplayer Option
ID: 4
Status: Approved
Priority: Critical
Effort: High
Risk: High
Stability: Low
Reason: The client wants this to be a game that can be played with friends. A multiplayer feature is an essential component of that request.

Single Player vs. AI
ID: 5
Status: Postponed
Priority: Useful
Effort: High
Risk: Low
Stability: Low
Reason: If a user wants to play, but doesn't have friends to play with, a single player version should be available. A single player version requires an AI opponent to play against.

Educational Pop-ups
ID: 6
Status: Approved

Priority: Critical
Effort: Medium
Risk: Low
Stability: High
Reason: In order to add more educational material to the game, it was decided to add the option to reveal more information about in-game elements such as equipment and papers.

Having Short and Long Games
ID: 7
Status: Approved
Priority: Critical
Effort: Low
Risk: Low
Stability: High
Reason: Just like in the actual board game, our program will allow for short and long games. It is so a person can play a game without having to devote as much time to playing, so they can play in a short amount of time.

Variations for Different Numbers of Players
ID: 8
Status: Approved
Priority: Important
Effort: Medium
Risk: Medium
Stability: Medium
Reason: The current game has slight variations to some of the rules if there are four people playing. Our program will need to reflect this change so the game remained a balanced just like in the actual board game.

Die Rolling
ID: 9
Status: Approved
Priority: Critical
Effort: Low
Risk: Low
Stability: Medium
Reason: In order to emulate the board game, a die roll should be present for movement.

Token/Avatar Selection

ID:10
Status: Approved
Priority: Critical
Effort: Low
Risk: Low
Stability: Medium
Reason: Can make the game more clear and empathetic.

Sound Effects
ID: 11
Status: Approved
Priority: Important
Effort: Low
Risk: Low
Stability: High
Reason: Sound effects are essential in any interactive game. Sounds will be triggered when certain events occur, such as the completion of the DNA sequence.

Tutorials for Different Features
ID: 12
Status: Proposed
Priority: Important
Effort: Medium
Risk: Medium
Stability: High
Reason: The game takes a lot of explaining to fully understand how the rules work. Including a tutorial would help beginners to understand the rules faster than just reading the rulebook.

A Help Page
ID: 13
Status: Approved
Priority: Critical
Effort: Low
Risk: Low
Stability: High
Reason: The rulebook needs to be available to players that are having trouble or want to check the rules for some reason. Putting the rulebook in the application allows players to look at it whenever they need to without it needing to be printed out.

View others Labs
ID: 14
Status: Approved

Priority: Critical
Effort: Medium
Risk: Medium
Stability: Medium
Reason: Biopioneer is a game of strategy. Many are based on viewing what each of your opponents is doing and developing strategies to combat them.

Board Representation
ID: 15
Status: Approved
Priority: Critical
Effort: High
Risk: Medium
Stability: Medium
Reason: Instead of paper board to represent different labs, use different scenarios in games to make it more interesting and real.

Random Initialization of Cards
ID: 16
Status: Approved
Priority: Critical
Effort: Medium
Risk: Medium
Stability: High
Reason: All shape, lab event, world problem, and DNA sequence cards need to be shuffled at the beginning of each game so that the cards are different every time the game is played.

Ability to choose a lab
ID: 17
Status: Approved
Priority: Medium
Effort: Low
Risk: Med
Stability: High
Reason: If all labs are shuffled, will somehow make player frustrated, if people is able to choose will make the game more attractive.

Turn Clock
ID: 18
Status: Proposed
Priority: Medium
Effort: Low

Risk: Med
Stability: High
Reason: Clock each turn will make the game more fair, but also will be bad if player is facing some connectivity issues.

Welcome Screen
ID: 19
Status: Approved
Priority: Critical
Effort: Low
Risk: Low
Stability: High
Reason: A welcome screen will be attractive and also a place for menu and different informations, even adds.

Card Selection
ID: 20
Status: Approved
Priority: Important
Effort: Medium
Risk: Low
Stability: Medium
Reason: Every turn players must select at least one card. A creative and artistic method of simulating cards in the application will be important to a good user experience.

Feature List:

ID	Feature	Effort	Risk
1	Touch Graphical User Interface	Easy	Med
2	Background Music	Low	Low
3	Themes for Different Players	Med	Low
4	2-4 Multiplayer	High	High
5	Single Player vs. AI	High	Low
6	Educational Popups	Med	Low
7	Short and Long Games	Low	Low
8	Variations for Different Numbers of Players	Med	Med

9	Die Rolling	Low	Low
10	Token/Avatar Selection	Low	Low
11	Sound Effects	Low	Low
12	Tutorials for different features	Med	Med
13	Help/Instructions	Low	Low
14	View Other Labs	Med	Med
15	Board Representation	High	Med
16	Random Initialization of Cards	Med	Med
17	Ability to Choose a Lab	Low	Med
18	Turn Clock	Low	Med
19	Welcome Screen	Low	Low
20	Card Selection	Med	Low

3.6 Use Cases:

Name: Starting a Game
ID: 1
Brief Description: The player sets up a new game by selecting the players, labs, tokens, and length of the game to be played. They will also use a generated profile for themselves.
Actors: User, other players
Preconditions:
- ->The Welcome Screen has displayed and the main menu is currently displayed.
- The user has created a profile.

Basic Flow:
1. User presses "New Game" button.
2. -> The screen prompts the user for the amount of players.
3. User chooses how many players that will play.
4. -> The screen asks the user if they want to use their profile.
5. The user selects yes.
6. -> The screen prompts the user to choose a profile of the second player, enter the name of the second player, or choose to make them be controlled by the computer.
7. The user enters the second player's name

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8   The rest of the users names are entered.

9   The user presses the "Next button"

10 `-> Die rolls are cast to determine the order of play and are shown on the screen.`

11 The person with the highest roll is prompted to choose a token.

12 The user presses the button corresponding to the token they want.

13 `-> The screen prompts the same user to choose which lab they want.`

14 The user chooses the lab they want.

15 `-> The screen prompts the second user to choose their token and then lab.`

16 The rest of the users choose their labs and tokens.

17 `-> The screen prompts the user if you want to play a short or long game.`

18 The user chooses short or long game.

19 `-> A random world problem is chosen and displayed on the screen with the requirements.`

20 `-> Random DNA sequences are assigned to each user.`

21 The user taps anywhere on the screen to start the game.

22 `-> The board is initialized and the first player is ready to start their turn.`

Alternate Flows:

3.a.   The user can choose different numbers of players.

5.a.1 The user selects no.

5.a.2 `-> The screen prompts the user for their name.`

5.a.3 The user enters their name.

7.a.   The user chooses to make the second player be played by the computer.

7.b   The second player chooses a profile.

8.a.   The amount of users to do this will change depending on the amount of players and how many are human players.

9.a.   The user can edit the other player's names or profile selection.

11.a. If the highest roll is assigned to a computer player, it will automatically choose a token and lab at random.

16.a. This will change depending on the number of players and if they are human (computer players' items are chosen at random).

18.a. The user chooses a long game

a.   The user closes the app at any time.

b.   The user cancels the new game at any time.

c.   The user goes back a step at any time.

d.   The game has an error at any time.

e.   The iPad battery dies.

Postconditions:

● The game is ready to play.

● All labs have been chosen and DNA strands are initialized.

- The world problem has been determined.
- The play order is determined.
- The board is initialized.
- Screen displays the board and prompts first user to start turn.

Name: Creating user profile
ID:2
Brief Description: Before start of the game, players have to create their user profiles so that each of the players can have a graphical token in the game, and also their profiles can be stored into memory play history and games.
Actors: User, and other players
Preconditions:
♦ Users have chosen to enter game
♦ .User is a new player or returning player
♦ User willing to use tokens or pictures to represent him/her
Basic Flow:
1. User tap on the "User Profile" button on the iPad screen
2. `-> Enter profile management interfaces`
3. User is a new player, tap the "Create" button
4: `-> Enter create interface, ask user to choose a picture from library or choose a token to represent him/her`
5: User done creating, tap on "Done" and then tap the "Back" buttons
6: `-> Back to profile management interface, show current user's profile and game history`
7: Each new player can do the same flow to create their profiles, when done, tap on the "Back" button back to main menu.
Alternate Flow:
3.a User is a return player, tap on the "Load Profile" button
4.a.1`-> Enter load profile interface, all the player data stored will be displayed`
4.a.2 `-> Users can take pictures via iPad's camera and use the picture as his/her profile picture`
5.a.1 Users choose one existing profile and load it as his/her profile, and tap "Back" button
Postcondition:
♦ The profiles for each player are set up
♦ The tokens and pictures loaded to the game
♦ The game is ready to start, users can skip the setup screen and jump to game

Name: Playing a turn
ID: 3
Brief Description: Once the game has started, users take turns rolling the dice, moving, selecting DNA, using abilities, obtaining resources, and completing actions.
Actors: User, Other players
Precondition:

- ● Players have started a game
- ● It is the beginning of a turn

Basic Flow:

1 User taps on the die
2 `-> Display die with random number between 1 and 6 inclusive`
3 User presses 'Move'
4 `-> Move user's piece the number of spaces indicated by the die`
5 `-> The DNA shape is revealed to the user`
6 User taps on shape card
7 `-> The DNA attaches itself to the player's DNA strand`
8 User taps 'continue'
9 `-> Present options to user`
10 User taps the person option
11 `-> Display the new person screen`
12 User taps the die
13 `-> Display die with random number between 1 and 6 inclusive`
14 `-> Decrement user's action counter`
15 User taps 'accept'
16 `-> Add person to the lab`
17 User taps 'continue'
18 `-> Display game board`
19 User taps 'end turn'
20 `-> Recalculate the user's action counter`
21 `-> Pass control to next player`
22 User passes the iPad

Alternate Flow:

      Random Events

a.   The user closes the app at any time.
b.   The game has an error at any time.
c.   The iPad battery dies.
d.1.   The User clicks on a lab at any time
d.2.   `-> Display selected player's lab`
e.1.   The user taps 'main menu' at any time
e.2.   `-> Switch to main menu`
f.   Step 10 and its alternates may be repeated as long as the user has actions
g.1   User tries to use an equipment for the second time that turn
g.2   `-> Indicate item has been used up`

      User wants to adjust their die roll

3.a.1. User taps 'Take Action'
3.a.2. `-> Present options to user`
3.a.3. User selects the pipette action
3.a.4. `-> Display info about pipette`
3.a.5. User taps 'use'

3.a.6.a.1   User taps the up arrow

3.a.6.a.2   `-> Die number increments`

3.a.6.b.1   User taps the down arrow

3.a.6.b.2   `-> Die number decrements`

3.a.7.   User taps 'accept''

3.b.   User may press back during steps 3.a.3 or 3.a.5

   The user lands on a lab event square

4.a.1   `-> User's piece stops when it reaches a lab event space`

4.a.2   `-> Present user with lab event`

4.a.3   User taps 'accept'

4.a.4   `-> Apply penalty or benefit to user`

4.a.5   `-> Continue to step 9`

   User lands on a star space

5.a   `-> Present shape options when user lands on star space`

   User wishes to use a piece of equipment

6.a.1   User taps 'take action'

6.a.2. `-> Present options to user`

6.a.3. User taps on an option

6.a.4. `-> Show info about option`

6.a.5. User taps 'use'

6.a.6. `-> Apply effects of option`

6.b.   User may tap 'back' during steps 6.a.3 and 6.a.5

   User wants to go for a paper (a), go for equipement (b), use an ability (c.) or win the game (d)

10.a.1 User taps the 'paper' option

10.a.2 `-> Display list of papers`

10.a.3 User taps on a paper

10.a.4 `-> Display info about selected paper`

10.b.1 User taps the 'equipment' option

10.b.2 `-> Display equipment tree`

10.b.3 User taps on an item

10.b.4 `-> Display detailed equipment information`

10.c.1 User taps the 'abilities' option

10.c.2 `-> Display user's abilities`

10.c.3 User selects an ability

10.c.4 `-> Display detailed ability information`

10.c.5 User taps 'use'

10.c.6 `-> Apply the ability and adjust action counter`

10.d.1 User taps 'solve world problem'

10.d.2 `-> Display world problem and requirements`

10.d.3 User taps the die

10.d.4 `-> Generate random number 1-6`

10.d.5.a `-> Display winning screen`
10.d.5.b `-> Indicate failure`
    User cannot roll the die again.
13.a `-> Indicate user has no remaining actions`
13.b `-> Indicate max number of people/turn`
13.c `-> Indicate max number of equipment/turn`
13.d `-> Indicate max number of papers/turn`
13.e `-> Indicate insufficient technology level`
    A player fails (a), gets a paper (b), or gets a piece of equipment (c.)
16.a `-> Display insufficient knowledge pool`
16.b `-> Add paper to lab`
16.c `-> Add equipment to lab`

Postcondition:
- It is no longer the player's turn

Name: Turn on/off music
ID: 4
Brief Description: There will be background music playing during the game, and it will be controlled by the user.
Actors: User, Other players
Preconditions:
- The game has been started

Basic Flow:
1. User taps on the options tab
2. `-> Options are presented to user on the screen and the game is blacked out`
3. User taps on the sound options button
4. `-> A list of sound options appear on screen with on/off options`
5. User taps ON or OFF on the background music option
6. `-> Background music turns either on or off depending on its previous state`
7. User taps EXIT to exit the options tab

Alternate Flow:
- a.   The user closes the app at any time.
- b.   The game has an error at any time.
- c.   The iPad battery dies.
- 1.a.   The enters the options tab
- 1.b.   The user can press the exit button to leave at any time
- 3.a   The user presses some other button by accident and turns on/off some other feature
- 3.b   The user can undo this action by re-tapping the same button
- d.   The user can also press exit at any time to leave the options tab

Postconditions:
- Board returns to original state

Name: Turn on/off sound effects
ID: 5
Brief Description: There will be background music playing during the game, and it will
Actors: User, Other players
Preconditions:
- The game has been started

Basic Flow:
1. User taps on the options tab
2. -> Options are presented to user on the screen and the game is blacked out
3. User taps on the sound options button
4. -> A list of sound options appear on screen with on/off options
5. User taps ON or OFF on the sound effects option
6. -> Sound effects turns either on or off depending on its previous state
7. User taps EXIT to exit the options tab

Alternate Flow:
- a.   The user closes the app at any time.
- b.   The game has an error at any time.
- c.   The iPad battery dies.
- 1.a.   The enters the options tab
- 1.b.   The user can press the exit button to leave at any time
- 3.a   The user presses some other button by accident and turns on/off some other feature
- 3.b   The user can undo this action by re-tapping the same button
- d.   The user can also press exit at any time to leave the options tab

Postconditions:
- None, the user can do nothing and just exit the options tab and the game will return to the board.
- Board returns to original state

Name: Hints
ID: 6
Brief Description: Beginners will be greeted with helpful hints as to what their options are during different phases of play.
Actors: User, Other players
Preconditions:
- The app has been started
- A game is in progress

Basic Flow:
1. User taps on the options tab

2 -> Options are presented to user on the screen and the game is blacked out
3 User taps on the hints button
4 -> The screen displays possible options for the player letting them know what they can do during that turn.
5 User views the advice
6 User taps EXIT to exit the options tab

Alternate Flow:
- a.   The user closes the app at any time.
- b.   The game has an error at any time.
- c.   The iPad battery dies.
- 1.a.   The enters the options or hints tab
- 1.b.   The user can press the exit button to leave at any time
- 3.a   The user presses some other button by accident and turns on/off some other feature
- 3.b   The user can undo this action by re-tapping the same button
- d.   The user can also press exit at any time to leave the options tab

Postconditions:
- ● Board returns to original state

Name: View Other Labs
ID: 7
Brief Description: The player can view any other player's lab during their turn to view their equipment, papers, and DNA.
Actors: User, Other players
Preconditions:
- ● The game has been started.
- ● It is a human player's turn.
- ● The lab contains at least one paper.

Basic Flow:
1 User touches other person's corner of the screen
2 -> Screen displays overview of other person's lab.
3 User touches the equipment tree.
4 -> Screen displays a more detailed view of the equipment tree and the player's equipment
5 User presses the exit button.
6 ->Screen displays overview of other person's lab again.
7 User taps a paper.
8 ->Screen displays a details about the paper.
9 User presses the exit button.
10 ->Screen displays overview of other person's lab again.
11 User presses the exit button.
12 -> Screen returns to the playing board

Alternate Flow:
- a.   The user closes the app at any time.

b. The game has an error at any time.
c. The iPad battery dies.
1.a. The user doesn't touch another person's lab corner.
3.a. The user doesn't touch the equipment tree.
3.b. The user taps on a paper instead.
3.c. The user presses the exit button.
7.a. The user doesn't touch a paper.
7.b. The user taps on the equipment tree instead.
7.c. The user presses the exit button.

Postconditions:
● The screen is back to the game board.

Name: View Tutorials
ID: 8
Brief Description: The player can view tutorials on how to play the game from the main menu.
Actors: User
Preconditions:
● The main menu is displayed.
Basic Flow:
1 User touches the tutorial button from the main menu.
2 ->The screen displays several different categories.
3 User touches a category.
4 ->The screen displays a screenshot and/or text describing an aspect of play.
5 User presses the "Next" button.
6 ->Another screenshot and/or text screen describing more appears.
7 User keeps pressing "Next" button until it no longer appears.
8 User presses the "Exit" button.
9 ->Screen returns to list of categories.
10 User presses the "Exit" button.
11 ->Screen returns to the main menu.
Alternate Flow:
3.a. The user selects a different category.
3.b The user presses the "Exit" button.
5.a. The user presses the "Exit" button.
7.a. The user presses the "Exit" button.
a. The user closes the app at any time.
b. The game has an error at any time.
c. The iPad battery dies.
Postconditions:
● The screen is back to the main menu.

Name: View Learning Center
ID: 9

Brief Description: The player can educate themselves in various topics concerning synthetic biology through tutorials in the learning center.
Actors: User
Preconditions:
- The main menu is displayed.

Basic Flow:
1 User opens game options menu
2 ->The screen displays several different options
3 User touches the Learning Center Button
4 ->The screen displays the learning center menu with a list of topics to choose from
5 User clicks on one of the topics
6 ->The screen is redirected to the page for that topic, including embedded links to youtube.com videos
7 User reads about the topic to learn
8 User presses the "BACK" button.
9 ->Screen returns to list of topics.
10 User presses the "EXIT" button.
11 ->Screen returns to the main menu.

Alternate Flow:
1.a.   The user exits the Learning Center at any time
1.b.   The screen returns to the game
4.a   The user clicks the wrong link
4.b   Pressing the BACK button will return the user to the Learning Center menu
a.   The user closes the app at any time.
b.   The game has an error at any time.
c.   The iPad battery dies.

Postconditions:
- The screen is back to the main menu.

Name: Ending a Game
ID: 10
Brief Description: After a game has been completed and a player has won, they are greeted with the option to return to the main menu or start a new game.
Actors: User
Preconditions:
- A game has just completed

Basic Flow:
1 `-> Display end screen`
2 User taps 'main menu' button

Alternate Flow:
2a1. User taps 'reset'
2a2. `-> Reset game based on last game's settings`

Postconditions:

- The ending screen is no longer displayed
- New game is created or Main menu is displayed

3.7 Feature Mapping

Use Case	Features
1. Starting a Game	(4)2-4 Multiplayer, (5)Single Player vs. AI, (7)Short and Long Games, (10)Token/Avatar Selection, (17)Ability to Choose a Lab,(16)Random Initialization of Cards, (19)Welcome screen
2. Creating a Profile	(3)Player profiles
3. Playing a Turn	(9)Die Rolling, (20)Card Selection, (6)Education Pop-ups, (18)Turn Clock
4. Turning on/off music	(2)Background Music
5. Turn on/off sound effects	(11)Sound Effects
6. Turn on/off hints	(13)Help/Instructions
7. View other labs	(14)View other labs
8. View tutorials	(12)Tutorials
9. Access Learning Center	(13)Help/Instructions
10. Ending a Game	

*Features not covered by the above use cases (1,8, and 15) are not functional requirements

3.8 Data Flow Diagrams:

All of these DFD's are for the proposed system because there is no current software system.

Player1

Player2

Player3

Player4

BioPoineer App

Control

iPad
Dispaly User Interfaces
Provice Control

Read Data

Save Data

iPad memory

Save user state
Game resources

1. Main menu

Select Path

4. Game

5.Lerning center

2.Options

3. Tutorials

Option selection
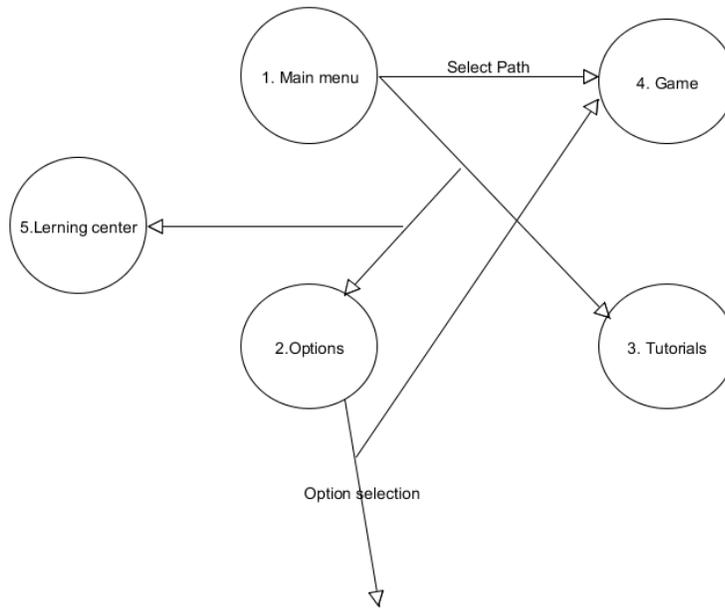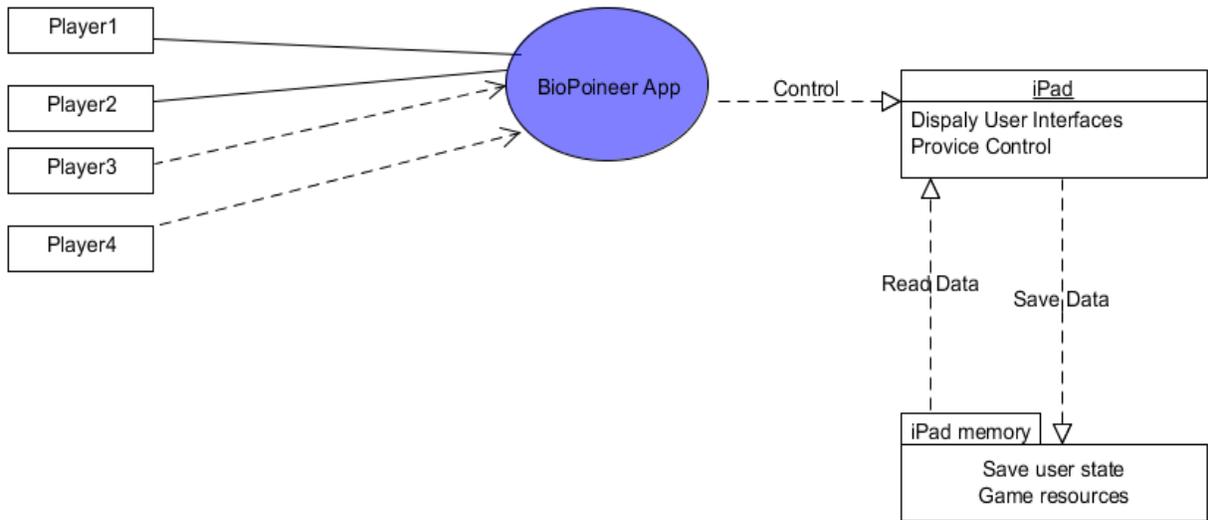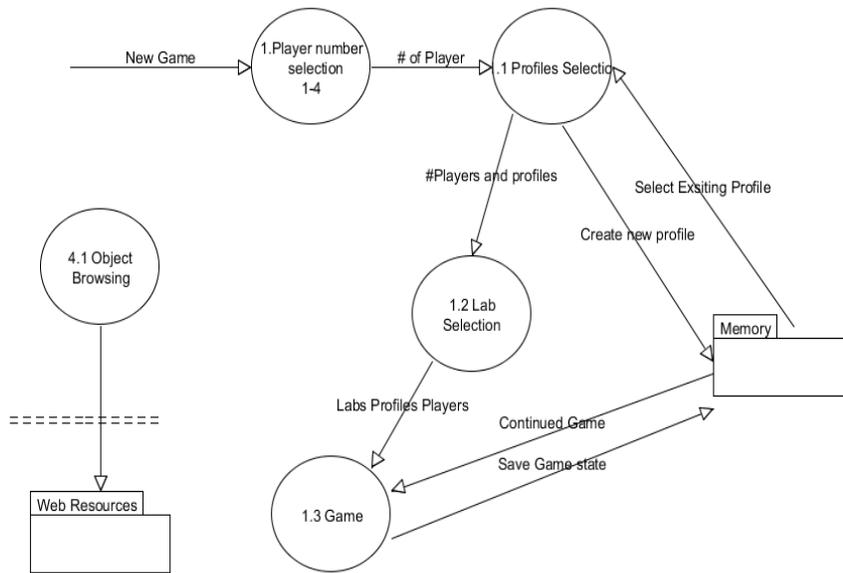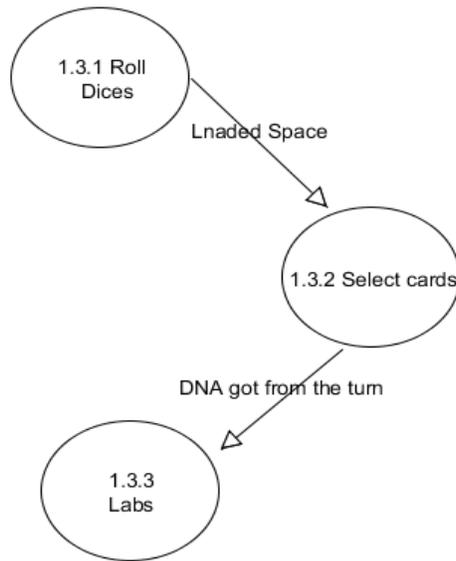
Level 0

Level 1

Level 2

3.9 Usability Requirements

Source of stimulus: User
Stimulus: User attempts to leave the application by pressing the home button
Artifact: Application
Environment: User is a student in a classroom playing in normal conditions.

Response: The application remains in focus
Response Measure: The student can waste 0 seconds outside the application.

Source of stimulus: User
Stimulus: User touches something that takes more than one second for the system to respond.
Artifact: Application
Environment: Normal conditions
Response: The application shows that it is doing something while it is loading.
Response Measure: A spinning load icon will appear whenever an action will take longer than one second to execute.

Source of stimulus: User
Stimulus: User wants to use the application and retain knowledge while playing.
Artifact: Application
Environment: The application is running normally and it is the user's first game
Response: Application is understood and educates the user
Response Measure: Users of high school age or above will be able to use the application on the first play through and will learn while they play.

Source of stimulus: User
Stimulus: User wishes to learn how to play the game
Artifact: Application
Environment: The application is running normally
Response: The application contains tutorials which will teach the user how to play.
Response Measure: After viewing the tutorials, users will understand how to play a game of Biopioneer

Source of stimulus: User
Stimulus: User wishes to be comfortable using the application
Artifact: Application
Environment: normal conditions
Response: The application is comfortable and easy to use
Response Measure: The application complies with Apple's User Interface Guidelines[8]

Source of stimulus: Color blind user
Stimulus: User wishes to be able play Biopioneer
Artifact: Application
Environment: User is color blind or deficient
Response: There is a color blind mode for the visually impaired.
Response Measure: A color blind user will be able to efficiently play a full game of Biopioneer with colors replaced by letters

3.10 Performance Requirements

Source of stimulus: User
Stimulus: User presses any button
Environment: normal conditions
Artifact: system
Response: minimize time it takes for button clicks
Response measure: all button clicks are less than one second

Source of stimulus: Multiple users
Stimulus: multiple users playing a game
Environment: normal conditions with four people playing
Artifact: system
Response: allow multiple people to play at once
Response measure: support up to four person multiplayer

Source of stimulus: CPU
Stimulus: degradation
Environment: under degradation
Artifact: system
Response: minimize degradation
Response measure: Even when degraded from all four players playing at once, the system will still respond in less than a sec.

3.11 Reliability Requirements

Source of stimulus: Memory (game resources)
Stimulus: Long time running(50mins) (lots of game frames, info boxes)
Environment: Full 4 player playing a full length game for a long time(50mins)
Artifact: iOS sandbox
Response: The game should maintain running without memory overflow and jump out and crash.
Response measure: The game will remain running

Source of stimulus: iOS file system
Stimulus: Read from user's or external data(pictures or external website)
Environment: User is try to upload their profile with their pictures or browsing external help websites
Artifact: iOS browser and iOS file system
Response: Despite the large data flow ,the game should remain running and normally respond to any command
Response measure: Game should remain running

3.12 Supportability Requirements

Source of stimulus: User
Stimulus: User updates the system
Environment: update is available
Artifact: system
Response: minimize problems with updating the app
Response measure: Using Apple standards[9] for updating, we will reduce problems with updating

Source of stimulus: programmer in the future
Stimulus: upgrades or changes the system
Environment: system
Artifact: system
Response: reduce the difficulty that the programmer will have reusing code
Response measure: make the changes easy to make by providing adequate documentation, and follow Apple coding standards.

3.13 Hardware and Software Interfaces

The Biopioneer application will be used on the Apple iPad's touch interface.

Source of stimulus: User
Stimulus: Performs a touch on the iPad
Artifact: Application
Environment: normal conditions
Response: The application registers a touch on the iPad and reacts accordingly
Response Measure: Touches are translated appropriately and respond are they are designed to do.

3.14 Documentation, Installation, Legal and Licensing

Documentation:
Source of stimulus: User, Future Coder
Stimulus: User downloads the system and opens up the documentation site
Environment: User is trying to learn about the application's design and use
Artifact: iOS file system, iOS browser

Response: The game should minimize and the website containing documentation
 should open up
Response measure: The browser will take the user to the website

Installation, Legal, and Licensing:
 All installation, legal, and licensing requirements are handled by the iPad's IOS.

 Source of stimulus: User
 Stimulus: User is installing BioPioneer
 Environment: User is trying to play the exciting new BioPioneer game
 Artifact: iOS AppStore and iOS file system, Game System
 Response: The download menu should pop up a place where users can agree to the
 legal requirements of the game before download begins
 Response measure: The game starts to downloading.

3.15 Design Constraints

Source	Constraint	Rationale
Systems	Touch Graphical User Interface	product is being developed for tablets or iphones, so no mouse clicks or keyboard events will be accessible
Budget	Client is only providing two SDK licenses.	The team only have access to two apple sdk keys because each one costs $100. However, there are four people in our group, so the team will have to share.
Systems	Screen Size of Device	This is a board game that will be translated to a tablet device, so everything will have to fit in a tighter area, while still looking presentable.
Systems	Processing Power and RAM in older devices	The Game's AI will potentially be a very complicated and greedy process. It will take up a lot of computing power in trying to figure out the best possible play
Tech Mandate	Must be programmed for Apple Devices	The client has requested that we make our game in objective-C using the Apple SDK.
Tech Mandate	Must meet Apple Guidelines	Apple products must meet the Apple Review Guidelines [11] in order to be published

3.16 User Interfaces

Appendix A contains a prototype for the main flow of the turn use case from Milestone 2. The usability of the application is aided by tutorials accessible from the main menu as well as helpful hints that appear during the user's first play through. Buttons are clearly labeled and large enough to be pressed easily. Educational content will be displayed only when a user has tapped on the object, so as not to distract or clog the screen. A user may access the tutorials through the main menu at any time during the game.

3.16.1 Design Goals

1. Visibility: The screen never appears crowded due to windows that appear and disappear based on user actions. Functions pop up once they are clicked on. Hints can be enabled to help new players know what to do next. Contrasting colors of touchable elements invite the user to touch them as opposed to the background.

2. Feedback: The application reacts to every user action. The user will always receive feedback whenever they touch a button or activate a game object.

3. Constraints: The user is limited to those actions that are relevant to the current state of play. During the course of a turn, the available buttons will change to reflect what the user's options are at that point in the turn sequence. Buttons and options that become obsolete at some point in a turn will be grayed out or marked as non-functional and no longer respond to the user's touch.

4. Consistency: The game will be internally and externally consistent
- Internal Consistencies:
  - Uniform buttons
  - Uniform font
  - Uniform naming
  - Uniform sizing
  - Uniform coloring schemes
- External Consistencies
  - Meets the standards of iPad touchability
  - Follows convention of button ordering
  - Follows naming conventions
  - Resembles existing board game

5. Affordances: All the game objects are distinguishable and can be intuitively used by players

3.17 Coding Standards

1. Function names should be meaningful and formatted to iPad/iOS standards[11].
2. No spelling mistakes should be there anywhere in the code. In comments, variable names and anywhere else.
3. No unnecessary empty lines, no unnecessary commented code.

4   Logical comments everywhere in the code, above functions and classes.
5   No magic numbers.
6   No function should be more than 40 lines. Make sub-functions. Complete function should be visible in single screen without scrolling.
7   Standard patterns for callbacks (proper names etc.)
8   Proper indentation of coding.(Follow Xcode instructions)
9   These things can be avoided by proper class/object oriented design.Use logic that will use less code (ex: predicates instead of for-loops). Make code simple and not complicated.
10 Proper error handling must be done. Functions should take error variable as parameter and should put error codes in it by the called function. The caller of the function should check this variable for any errors.
11 Destroy allocated memory when dealloc method is called.
12 Put spaces in between each variable and operator in equations instead of grouping everything together.
13 Write TODOS for things that you haven't completed yet, but plan to.

3.18 Change Control

There are three types of changes that we need to account for. The first type is a change in code, the second is a change in requirements, and the third is a change in documents.

3.18.1 Ways to control code changes:

- Use SVN to track changes in code
- Inform team members when code is changed
- Set up email with SVN to notify when a commit occurs
- Team members should detail the changes made in each commit, and the reasons
- Conflicts should be handled by one designated person

3.18.2 Ways to control requirement changes:

- Talk to the client and update him often
- Try to catch these changes early
- Discuss the change in requirements with the team before deciding to implement
- Analyze the cascading impact on other aspects of the project
- Analyze the risks involved and potential to destabilize the system
- If after analysis the majority of the team supports integration of the new feature, begin design and implementation
- Inform client of final decision and provide rationale.

3.18.3 Ways to control document changes:

○ Include a version table at the top of each written deliverable including the date, version, and the changes made.
  ○ Update the table whenever a major change has been made.
  ○ Ensure updated documents are accessible by all team members through Google Drive.

3.19 Test Cases

Use Case Name: Starting a Game
ID: 1
Brief Description: The player sets up a new game by selecting the players, labs, tokens, and length of the game to be played. They will also use a generated profile for themselves.
Actors: User, other players
Preconditions:
● ->The Welcome Screen has displayed and the main menu is currently displayed.
● The user has created a profile.
Basic Flow:
1 User presses "New Game" button.
2 -> The screen prompts the user for the amount of players.
3 User chooses how many players that will play.
4 -> The screen asks the user if they want to use their profile.
5 The user selects yes.
6 -> The screen prompts the user to choose a profile of the second player, enter the name of the second player, or choose to make them be controlled by the computer.
7 The user enters the second player's name
8 The rest of the users names are entered.
9 The user presses the "Next button"
10 -> Die rolls are cast to determine the order of play and are shown on the screen.
11 The person with the highest roll is prompted to choose a token.
12 The user presses the button corresponding to the token they want.
13 -> The screen prompts the same user to choose which lab they want.
14 The user chooses the lab they want.
15 -> The screen prompts the second user to choose their token and then lab.
16 The rest of the users choose their labs and tokens.
17 -> The screen prompts the user if you want to play a short or long game.
18 The user chooses short or long game.
19 -> A random world problem is chosen and displayed on the screen with the requirements.

`20 -> Random DNA sequences are assigned to each user.`

21 The user taps anywhere on the screen to start the game.

`22 -> The board is initialized and the first player is ready to start their turn.`

Alternate Flows:

3.a.   The user can choose different numbers of players.

5.a.1   The user selects no.

`5.a.2 -> The screen prompts the user for their name.`

5.a.3   The user enters their name.

7.a.   The user chooses to make the second player be played by the computer.

7.b   The second player chooses a profile.

8.a.   The amount of users to do this will change depending on the amount of players and how many are human players.

9.a.   The user can edit the other player's names or profile selection.

11.a.   If the highest roll is assigned to a computer player, it will automatically choose a token and lab at random.

16.a.   This will change depending on the number of players and if they are human (computer players' items are chosen at random).

18.a.   The user chooses a long game

a.   The user closes the app at any time.

b.   The user cancels the new game at any time.

c.   The user goes back a step at any time.

d.   The game has an error at any time.

e.   The iPad battery dies.

Postconditions:
- The game is ready to play.
- All labs have been chosen and DNA strands are initialized.
- The world problem has been determined.
- The play order is determined.
- The board is initialized.
- Screen displays the board and prompts first user to start turn.

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
1.1	1.1	Basic Flow: User presses the "New Game" button to begin	User is at the main menu.	Screen changes and prompts user to specify the number of players.
1.2	1.2.a	Basic Flow: User chooses two people	There are two people playing	Screen asks first user if they will use a profile

1.3	1.2.b	Basic Flow: User chooses three people	There are three people playing	Screen asks first user if they will use a profile
1.4	1.2.c	Basic Flow: User chooses four people	There are four people playing	Screen asks first user if they will use a profile
1.5	1.3.a	Basic Flow: User chooses yes	At least one profile is made	The screen will prompt the user to select a profile.
1.6	1.3.b	Alternate Flow: User chooses no		The screen will prompt the user to enter their name.
1.7	1.4.a	Basic Flow: User selects the profile they want to use	The user has a profile	The screen prompts the second user to choose a profile, enter a name, or be played by the computer.
1.8	1.4.b	Alternate Flow: User enters their name		The screen prompts the second user to choose a profile, enter a name, or be played by the computer.
1.9	1.5.a	Basic Flow: Second User chooses a profile	The second user has a profile	The screen prompts the third user to choose a profile, enter a name, or be played by the computer.
1.10	1.5.a	Basic Flow: Second User chooses a profile	The second user has a profile	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.11	1.5.b	Alternate Flow: Second User enters their name		The screen prompts the third user to choose a profile, enter a name, or be played by the computer.
1.12	1.5.b	Alternate Flow: Second User enters their name		The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.13	1.5.c	Alternate Flow: Second User is set as the computer	A.I. has been implemented	The screen prompts the second user to choose a profile, enter a name, or be played by the computer.

		Alternate Flow: Second User is set as the computer	A.I. has been implemented	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.14	1.5.c			
1.15	1.6.a	Basic Flow: Third User chooses a profile	The third user has a profile	The screen prompts the fourth user to choose a profile, enter a name, or be played by the computer.
1.16	1.6.a	Basic Flow: Third User chooses a profile	The third user has a profile	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.17	1.6.b	Alternate Flow: Third User enters their name		The screen prompts the fourth user to choose a profile, enter a name, or be played by the computer.
1.18	1.6.b	Alternate Flow: Third User enters their name		The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.19	1.6.c	Alternate Flow: Third User is set as the computer	A.I. has been implemented	The screen prompts the fourth user to choose a profile, enter a name, or be played by the computer.
1.20	1.6.c	Alternate Flow: Third User is set as the computer	A.I. has been implemented	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.21	1.7.a	Basic Flow: Fourth User chooses a profile	The fourth user has a profile	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.22	1.7.b	Alternate Flow: Fourth User enters their name		The computer rolls a die for each player and the results are displayed. The player with the highest roll is

				prompted to choose a token.
1.23	1.7.c	Alternate Flow: Fourth User is set as the computer	A.I. has been implemented	The computer rolls a die for each player and the results are displayed. The player with the highest roll is prompted to choose a token.
1.24	1.8.a	Basic Flow: The player with the highest roll chooses a token	The player with the highest roll is human	That player is now associated with that token and is then prompted to choose a lab.
1.25	1.8.b	Alternate Flow: The computer chooses a token at random and then chooses a lab at random	The highest roll belongs to a computer player	The next highest roller is then prompted to choose a token.
1.26	1.9	Basic Flow: That player chooses a lab that they want to use		The player is associated with that lab and the next player is prompted.
1.27	1.10.a	Alternate Flow: The player with the next highest roll chooses a token	The player with the next highest roll is human	That player is now associated with that token and is then prompted to choose a lab.
1.28	1.10.b	Alternate Flow: The computer chooses a token at random and then chooses a lab at random	The next highest roll belongs to a computer player	The next highest roller is then prompted to choose a token.
1.29	1.11	Alternate Flow: That player chooses a lab that they want to use		The player is associated with that lab and the next player is prompted.
1.30	1.12.a	Alternate Flow: The player with the next highest roll chooses a token	The player with the next highest roll is human	That player is now associated with that token and is then prompted to choose a lab.
1.31	1.12.b	Alternate Flow: The computer chooses a token at random and then chooses a lab at random	The highest roll belongs to a computer player	The last roller is then prompted to choose a token.

1.32	1.13	Alternate Flow: That player chooses a lab that they want to use		The player is associated with that lab and the last player is prompted.
1.33	1.14.a	Alternate Flow: The last player chooses a token that they want	The last player is human.	The last player is now associated with that token and is then prompted to choose a lab.
1.34	1.14.b	Alternate Flow: The computer chooses a token at random and then chooses a lab at random	The lowest roll belongs to a computer player	The user is prompted to choose between a short and long game.
1.35	1.15	Alternate Flow: The last player chooses a lab that they want to use.		The user is prompted to choose between a short and long game.
1.36	1.16	Basic Flow: The user chooses a short game.		Random DNA sequences that are six pieces long are generated for each player.
1.37	1.16	Alternate Flow: The user chooses a long game.		Random DNA sequences that are twelve pieces long are generated for each player.
1.38	1.17	The user taps the screen anywhere to start the game.		The board is initialized and the first player is ready to start their turn.

Name: Creating user profile
ID:2
Brief Description: Before start of the game, players have to create their user profiles so that each of the players can have a graphical token in the game, and also their profiles can be stored into memory play history and games.
Actors: User, and other players
Preconditions:
    ♦ Users have chosen to enter game
    ♦ User is a new player or returning player
    ♦ User willing to use tokens or pictures to represent him/her
Basic Flow:
 1. User tap on the "User Profile" button on the iPad screen
  2. `-> Enter profile management interfaces`
 3. User is a new player, tap the "Create" button

4: `-> Enter create interface, ask user to choose a picture from` library or choose a token to represent him/her

5: User done creating, tap on "Done" and then tap the "Back" buttons

6: `-> Back to profile management interface, show current user's` profile and game history

7: Each new player can do the same flow to create their profiles, when done, tap on the "Back" button back to main menu.

Alternate Flow:

3.a User is a return player, tap on the "Load Profile" button

4.a.1`-> Enter load profile interface, all the player data stored will` be displayed

4.a.2 `-> Users can take pictures via iPad's camera and use the picture` as his/her profile picture

5.a.1 Users choose one existing profile and load it as his/her profile, and tap "Back" button

Postcondition:

      ♦ The profiles for each player are set up

      ♦ The tokens and pictures loaded to the game

      ♦ The game is ready to start, users can skip the setup screen and jump to game interface.

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
2.1	2.1	Users should be ask to create a profile.	Users are new players	Enter "profile" interface
2.2	2.2	The iPad screen should display the profile manage interface		The iPad screen should display the profile manage interface
2.3	2.3	Choose to create a new profile	Users are new players	The iPad screen should display the creating profile interface
2.4	2.3.a	Choose to load existing profiles	Users are return players	The iPad screen should display the load profile interface
2.5	2.4	Creating a profile	Users want to choose a picture in iPad to represent him/her	The app should respond to user's action and open the iPad picture library

2.6	2.4.a.1	Choose profile picture	User choose to use pre-set pictures in app	User will be able to choose pictures from the game.
2.7	2.4.a.2	Take pictures and then use it as profile picture	User choose to take a picture with iPad's cameras and then use the picture as their profile picture	User will be able to take pictures and then use it as profile picture
2.8	2.5	Exit profile management interface	Users done choosing profiles and prepare to exist profile management interface	User will tap the "back" button and exit profile management interface

Use Case Name: Playing a turn
ID: 3
Brief Description: Once the game has started, users take turns rolling the dice, moving, selecting DNA, using abilities, obtaining resources, and completing actions.
Actors: User, Other players
Precondition:
- ● Players have started a game
- ● It is the beginning of a turn

Basic Flow:
1 User taps on the die
2 -> Display die with random number between 1 and 6 inclusive
3 User presses 'Accept'
4 -> Move user's piece the number of spaces indicated by the die
5 -> The DNA shape is revealed to the user
6 User taps on shape card
7 -> The DNA attaches itself to the player's DNA strand
8 User taps 'continue'
9 -> Present options to user
10 User taps the person option
11 -> Display the new person screen
12 User taps the die
13 -> Display die with random number between 1 and 6 inclusive
14 -> Decrement user's action counter
15 User taps 'accept'
16 -> Add person to the lab
17 User taps 'continue'
18 -> Display game board
19 User taps 'end turn'

20 -> Recalculate the user's action counter
21 -> Pass control to next player
22 User passes the iPad

Alternate Flow:

Random Events

a.   The user closes the app at any time.

b.   The game has an error at any time.

c.   The iPad battery dies.

d.1.   The User clicks on a lab at any time

d.2.   -> Display selected player's lab

e.1.   The user taps 'main menu' at any time

e.2.   -> Switch to main menu

f.   Step 10 and its alternates may be repeated as long as the user has actions

g.1   User tries to use an equipment for the second time that turn

g.2   -> Indicate item has been used up

User wants to adjust their die roll

3.a.1.   User taps 'Take Action'

3.a.2.   -> Present options to user

3.a.3.   User selects the pipette action

3.a.4.   -> Display info about pipette

3.a.5.   User taps 'use'

3.a.6.a.1   User taps the up arrow

3.a.6.a.2   -> Die number increments

3.a.6.b.1   User taps the down arrow

3.a.6.b.2   -> Die number decrements

3.a.7.   User taps 'accept''

3.b.   User may press back during steps 3.a.3 or 3.a.5

The user lands on a lab event square

4.a.1   -> User's piece stops when it reaches a lab event space

4.a.2   -> Present user with lab event

4.a.3   User taps 'accept'

4.a.4   -> Apply penalty or benefit to user

4.a.5   -> Continue to step 9

User lands on a star space

5.a   -> Present shape options when user lands on star space

User wishes to use a piece of equipment

6.a.1   User taps 'take action'

6.a.2.   -> Present options to user

6.a.3.   User taps on an option

6.a.4.   -> Show info about option

6.a.5.   User taps 'use'

6.a.6.   -> Apply effects of option

6.b.   User may tap 'back' during steps 6.a.3 and 6.a.5

User wants to go for a paper (a), go for equipement (b), use an ability (c.) or win the game (d)

10.a.1 User taps the 'paper' option

10.a.2 `-> Display list of papers`

10.a.3 User taps on a paper

10.a.4 `-> Display info about selected paper`

10.b.1 User taps the 'equipment' option

10.b.2 `-> Display equipment tree`

10.b.3 User taps on an item

10.b.4 `-> Display detailed equipment information`

10.c.1 User taps the 'abilities' option

10.c.2 `-> Display user's abilities`

10.c.3 User selects an ability

10.c.4 `-> Display detailed ability information`

10.c.5 User taps 'use'

10.c.6 `-> Apply the ability and adjust action counter`

10.d.1 User taps 'solve world problem'

10.d.2 `-> Display world problem and requirements`

10.d.3 User taps the die

10.d.4 `-> Generate random number 1-6`

10.d.5.a `-> Display winning screen`

10.d.5.b `-> Indicate failure`

User cannot roll the die again.

13.a `-> Indicate user has no remaining actions`

13.b `-> Indicate max number of people/turn`

13.c `-> Indicate max number of equipment/turn`

13.d `-> Indicate max number of papers/turn`

13.e `-> Indicate insufficient technology level`

A player fails (a), gets a paper (b), or gets a piece of equipment (c.)

16.a `-> Display insufficient knowledge pool`

16.b `-> Add paper to lab`

16.c `-> Add equipment to lab`

Postcondition:

- It is no longer the player's turn

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
3.1	3.1	Basic Flow: User taps the die to begin their turn	It is the user's turn	The die displays a random number between 1 and 6
3.2	3.2.a	Basic Flow: User	The die rolled to display	The player's piece

		taps 'accept' to confirm the roll	a number (ex. 4) that is less than the distance to a lab event (ex. 8) and puts the player on a star	moves the number of spaces on die and all 3 DNA card piles are shown
3.3	3.2.a	Basic Flow: User taps 'accept' to confirm the roll	The die rolled to display a number (ex. 4) that is less than the distance to a lab event (ex. 8) and puts the player on a circle, square, or triangle	The player's piece moves the number of spaces on die and the shape card pile matching the space is shown.
3.4	3.2.a	Basic Flow: User taps 'accept' to confirm the roll	The die rolled to display a number (ex. 4) that is greater than the distance to a lab event (ex. 2)	The players piece moves to the lab event space and a lab card is shown
3.5	3.2.b	Alternate Flow: User taps 'take action' button to select an ability to use	The die rolled to display a number (ex. 4) & the user has a pipette left	A menu appears showing the pipette
3.6	3.2.b	Alternate Flow: User taps 'take action' button to select an ability to use	The die rolled to display a number (ex. 4) & the player has no pipette	Game indicates that the user has no usable abilities
3.7	3.3.a	Alternate Flow: User taps the pipette to select it	The user has a pipette	A description of the pipette is displayed
3.8	3.3.b	Alternate Flow: User taps 'cancel'		The abilities menu disappears
3.9	3.4.a	Alternate Flow: User taps 'use' from the pipette menu to use it	The number on the die is between 2 and 5 inclusive (ex. 4)	Menu disappears, arrows appear on the die, and cancel button appears
3.10	3.4.a	Alternate Flow: User taps 'use' from the pipette menu to use it	The number on the die is a 6	Same as above, except no up arrow appears
3.11	3.4.a	Alternate Flow: User taps 'use' from the pipette menu to use it	The number on the die is a 1	Same as above, no down arrow appears
3.12	3.4.b	Alternate Flow: User taps 'back' from the		The pipette menu disappears leaving

		pipette menu		the abilities menu
3.13	3.5.a	Alternate Flow: User taps the up arrow on the die to increment the number	The number on the die is equal to the original roll (ex. 4)	The number on the die increments and the up arrow clears
3.14	3.5.a	Alternate Flow: User taps the up arrow on the die to increment the number	The number on the die is one less than the original roll (ex. 3)	The number increments and the down arrow returns
3.15	3.5.b	Alternate Flow: User taps the down arrow on the die to decrement the number	The number on the die is equal to the original roll (ex. 4)	Number on the die decrements and the down arrow clears
3.16	3.5.b	Alternate Flow: User taps the down arrow on the die to decrement the number	The number on the die is one greater than the original roll (ex. 5)	Number on the die decrements and the up arrow returns
3.17	3.5.c	Alternate Flow: User taps 'cancel' to cancel use of the pipette		Number on the die returns to original and arrows clear
3.18	3.5.d	Alternate Flow: User taps 'accept' to move the no. of spaces on the die	Pipette is in use and the number on the die is equal to the original number	Result of 3.2.a
3.19	3.5.d	Alternate Flow: User taps 'accept' to move the no. of spaces on the die	Pipette is in use and the number on the die is not equal to the original number	Result of 3.2.a and the user's pipette is removed
3.20	3.6.a	Basic Flow: The user is presented with one DNA pile and taps on it to reveal the DNA color		The card turns to reveal the color of the DNA
3.21	3.6.b	Alternate Flow: The user is presented with one DNA pile and taps the 'take	The user has an unused PCR Machine or Autoclave	A menu appears showing the PCR Machine and/or Autoclave that the

		action' button		user has.
3.22	3.6.b	Alternate Flow: The user is presented with one DNA pile and taps the 'take action' button	The user has no PCR Machine or Autoclave	The game indicates the player has no usable abilities
3.23	3.7.a	Alternate Flow: The user selects the PCR Machine from the menu	The user has an unused PCR Machine	A description of the PCR Machine is displayed
3.24	3.7.a	Alternate Flow: The user selects the PCR Machine from the menu	The user does not have an unused PCR Machine	The game indicates the PCR Machine has been depleted.
3.25	3.7.b	Alternate Flow: The user selects the Autoclave from the menu	The user has an unused Autoclave	A description of the Autoclave is displayed
3.26	3.7.b	Alternate Flow: The user selects the Autoclave from the menu	The user does not have an unused Autoclave	The game indicates the Autoclave has been depleted.
3.27	3.7.c	Alternate Flow: From the menu, the user taps 'cancel'		The abilities menu disappears
3.28	3.7.d	Alternate Flow: The user taps on the DNA while the menu is open	The menu is open	Nothing happens
3.29	3.8.a	Alternate Flow: From the PCR Machine window, the user taps 'use'		The menus disappear and two DNA cards of the shape landed on are revealed
3.30	3.8.b	Alternate Flow: From the PCR Machine window the user taps 'cancel'		The PCR Machine Window closes and the abilities menu is in focus
3.31	3.8.a	Alternate Flow: From the Autoclave		The menus disappear and three DNA cards

		window, the user taps 'use'		of the shape landed on are revealed
3.32	3.8.b	Alternate Flow: From the Autoclave window the user taps 'cancel'		The Autoclave Window closes and the abilities menu is in focus
3.33	3.9.a	Basic Flow: The color of the DNA cards has been revealed and the user taps the card they want.	The DNA card matches the next space in the player's sequence	The player's lab comes into focus and the DNA is added.
3.34	3.9.a	Basic Flow: The color of the DNA cards has been revealed and the user taps the card they want.	The DNA card does not match the next space in the player's sequence	The player's lab comes into focus and the DNA is rejected.
3.35	3.9.a	Basic Flow: The color of the DNA cards has been revealed and the user taps the card they want.	The player had used a PCR Machine to get 2 cards	The DNA is added or rejected as above and the player is prompted to choose where to put the non-chosen card
3.36	3.9.b	Alternate Flow: The color of the DNA cards has been revealed and the user taps the 'take action' button	The player has PCR Amplification, Restriction Digest, Site Specific Mutogenesis, Homologous Recombination, a Media Plate, Gel Electrophoresis, a Centrifuge, or the Shibberu paper	The abilities menu is displayed containing any of the items to the left that the player has
3.37	3.9.b	Alternate Flow: The color of the DNA cards has been revealed and the user taps the 'take action' button	The player does not have any of the abilities or items listed above	The game indicates that the player has no usable abilities
3.38	3.10.a*	Alternate Flow: The user selects an item from the abilities menu	The ability or item chosen has not been used this turn	The item's window appears

3.39	3.10.a	Alternate Flow: The user selects an item from the abilities menu	The ability or item chosen has already been used this turn	The game indicates that the chosen item has been depleted
3.40	3.10.b	Alternate Flow: From the abilities menu, the user taps 'cancel'		The abilities menu disappears
3.41	3.11.a*	Alternate Flow: The user has chosen an ability and taps 'use'		The menus disappear and the ability is applied
3.42	3.11.b	Alternate Flow: The user has chosen an ability but taps 'cancel'		The item's window closes and abilities menu appears
3.43	3.12.a	Basic Flow: The user is in the main phase of the turn and taps the 'people' button to try for a person	The user has at least one action point (ex. 2) and has not received a person yet this turn	The people window appears and prompts the user to roll
3.44	3.12.a	Basic Flow: The user is in the main phase of the turn and taps the 'people' button to try for a person	The user has no actions left this turn	The game indicates that the player has run out of actions and must end their turn
3.45	3.12.a	Basic Flow: The user is in the main phase of the turn and taps the 'people' button to try for a person	The user has already obtained a person this turn	The game indicates that the player has already reached maximum people for that turn
3.46	3.12.b	Alternate Flow: The user is in the main phase of the turn and taps the 'equipment' button to try for some equipment	The user has at least one action point (ex. 2) and has not received 2 pieces of equipment yet (ex. 1) this turn	The equipment menu appears
3.47	3.12.b	Alternate Flow: The user is in the main phase of the turn and taps the 'equipment' button to try for some equipment	The user has no actions left this turn	The game indicates that the player has run out of actions and must end their turn

3.48	3.12.b	Alternate Flow: The user is in the main phase of the turn and taps the 'equipment' button to try for some equipment	The user has already obtained 2 pieces of equipment this turn	The game indicates that the player has already reached maximum equipment for that turn
3.49	3.12.c	Alternate Flow: The user is in the main phase of the turn and taps the 'paper' button to try for some equipment	The user has at least one action point (ex. 2) and has not received a paper this turn	The papers menu appears
3.50	3.12.c	Alternate Flow: The user is in the main phase of the turn and taps the 'paper' button to try for some equipment	The user has no actions left this turn	The game indicates that the player has run out of actions and must end their turn
3.51	3.12.c	Alternate Flow: The user is in the main phase of the turn and taps the 'paper' button to try for some equipment	The user has already obtained a paper this turn	The game indicates that the player has already reached maximum papers for that turn
3.52	3.12.d	Alternate Flow: The user is in the main phase of the turn and taps the 'abilities' button to try for some equipment	The user has actions left and an unused incubator or centrifuge	The abilities menu appears showing the incubator and/or centrifuge
3.53	3.12.d	Alternate Flow: The user is in the main phase of the turn and taps the 'abilities' button to use an ability	The user has no actions left this turn	The game indicates that the player has run out of actions and must end their turn
3.54	3.12.d	Alternate Flow: The user is in the main phase of the turn and taps the 'abilities' button to use an ability	The user has no unused incubator or centrifuge	The game indicates that the player has already exhausted abilities

3.55	3.12.e	Basic Flow: The user taps the 'end turn' button to end their turn	The user has no actions left	The player's turn ends and the next person must roll
3.56	3.12.e	Basic Flow: The user taps the 'end turn' button to end their turn	The user has remaining actions for the turn	A confirm box appears to verify the end of the turn
3.57	3.12.f	Alternate Flow: The user taps 'solve problem' to attempt to win the game	The user has actions remaining this turn	The world problem window appears
3.58	3.12.f	Alternate Flow: The user taps 'solve problem' to attempt to win the game	The user has no actions remaining this turn	The game indicates that the player has run out of actions and must end their turn
3.59	3.13.a	Basic Flow: From the people window, the user taps on the die	The user has remaining actions	The die rolls to reveal a number between 1-6
3.60	3.13.a	Basic Flow: From the people window, the user taps on the die	The user has no remaining actions	The game indicates the user has depleted their actions
3.61	3.13.b	Alternate Flow: From the people window, the user taps 'cancel'		The people window disappears
3.62	3.14.a*	Alternate Flow: From the equipment menu, the user taps on a piece of equipment		The object's window is displayed.
3.63	3.14.b	Alternate Flow: From the equipment menu, the user taps 'cancel'		The equipment menu disappears
3.64	3.15.a	Alternate Flow: From an object's window the user taps the die	The user has an action and the equipment fits into the user's tech tree	The die displays a number between 1 and 6.
3.65	3.15.a	Alternate Flow: From an object's window the user taps the die	The user has run out of actions	The game indicates the user has no actions

3.66*	3.15.a	Alternate Flow: From an object's window the user taps the die	The player does not have the prerequisite equipment	The game tells the user they lack prerequisite tech
3.67	3.15.b	Alternate Flow: From an objects window the user taps 'cancel'		The item's window disappears
3.68	3.16.a*	Alternate Flow: From the papers menu the user selects a paper		The item's window appears
3.69	3.16.b	Alternate Flow: From the papers menu the user taps 'cancel'		The papers menu disappears
3.70	3.17.a	Alternate Flow: From the paper's window the user taps the die	The user has available actions	The die displays a number between 1 and 6
3.71	3.17.a	Alternate Flow: From the paper's window the user taps the die	The user has no actions left	The game indicates the user has no actions
3.72	3.17.b	Alternate Flow: From the paper's window the user taps 'cancel'		The paper's window disappears
3.73	3.18.a	Alternate Flow: From the world problem window, the user taps the die.	The user has available actions and meets the problem requirements	The die displays a number between 1 and 6
3.74	3.18.a	Alternate Flow: From the world problem window, the user taps the die.	The user has no available actions	The game indicates the user has no actions
3.74	3.18.a	Alternate Flow: From the world problem window, the user taps the die.	The user does not meet requirements to win the game	The game indicates the user is not ready to solve the problem
3.75	3.18.b	Alternate Flow: From the world problem window, the user taps 'cancel'		The world problem window closes
3.73	3.19*	Basic Flow: When	The accepted roll results	The item is added to

		rolling for a person, equipment, or paper the player has the option to use the pipette as before. Eventually the user taps 'accept'	in a knowledge pool greater than or equal to the required pool for the attempted goal	the users lab or in the case of the world problem, the player wins.The pipette is remove if used
3.74	3.19	Basic Flow: When rolling for a person, equipment, or paper the player has the option to use the pipette as before. Eventually the user taps 'accept'	The accepted roll results in a knowledge pool less than the required pool for the attempted goal	The game indicates failure and in the case of the world problem the turn ends. The pipette is removed if used.
3.75	3.20.a*	Alternate Flow: From the abilities menu the user chooses an ability		The ability's window is displayed
3.76	3.20.b	Alternate Flow: From the abilities menu the user taps 'cancel'		The abilities menu disappears
3.77	3.21.a*	Alternate Flow: From an abilities window, the user taps 'use'	The chosen ability has not been used this turn and the user has enough actions	The ability is applied
3.78	3.21.a	Alternate Flow: From an abilities window, the user taps 'use'	The chosen ability has been used this turn	The game indicates the user has exhausted the ability
3.79	3.21.a	Alternate Flow: From an abilities window, the user taps 'use'	The user does not have enough actions to use the ability	The game indicates the user lacks sufficient actions
3.79	3.21.b	Alternate Flow: From an abilities window, the user taps 'cancel'		The ability's window disappears
3.80	3.22	Alternate Flow: At any point the user taps the 'main menu' button		The main menu is displayed and the game is saved

User Case Name: Turning on/off music

ID: 4

Brief Description: There will be background music playing during the game, and it will be controlled by the user.

Actors: User, Other players

Preconditions:
- The game has been started

Basic Flow:
1 User taps on the options tab
2 `-> Options are presented to user on the screen and the game is blacked out`
3 User taps on the sound options button
4 `-> A list of sound options appear on screen with on/off options`
5 User taps ON or OFF on the background music option
6 `-> Background music turns either on or off depending on its previous state`
7 User taps EXIT to exit the options tab

Alternate Flow:
a. The user closes the app at any time.
b. The game has an error at any time.
c. The iPad battery dies.
1.a. The enters the options tab
1.b. The user can press the exit button to leave at any time
3.a The user presses some other button by accident and turns on/off some other feature
3.b The user can undo this action by re-tapping the same button
d. The user can also press exit at any time to leave the options tab

Postconditions:
- Board returns to original state

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
4.1	4.1	Basic Flow: User taps the option tab	user is in the game	The options tab opens up for the player
4.1	4.1.a	Alternate Flow: the user closes the app or the ipad dies at any time		No changes are saved
4.2	4.2	Basic Flow: User taps on the sound options button		A list of sound options appear on the screen with on/off options

4.2	4.2.a	Alternate Flow: User clicks the wrong option button	user is in options tab	The incorrect option is chosen
4.2	4.2.b	Alternate Flow: Undo the wrong option by reclicking		Goes back to previous state
4.3	4.3	Basic Flow: User taps on/off on background music option		The background music turns either on or off depending on its previous state
4.4	4.4	Basic Flow: The user taps the exit button to leave the options tab		The game returns to its orginial state

Use Case Name: Turn on/off sound effects
ID: 5
Brief Description: There will be background music playing during the game, and it will
Actors: User, Other players
Preconditions:
● The game has been started
Basic Flow:
1 User taps on the options tab
2 `-> Options are presented to user on the screen and the game is blacked out`
3 User taps on the sound options button
4 `-> A list of sound options appear on screen with on/off options`
5 User taps ON or OFF on the sound effects option
6 `-> Sound effects turns either on or off depending on its previous state`
7 User taps EXIT to exit the options tab
Alternate Flow:
a. The user closes the app at any time.
b. The game has an error at any time.
c. The iPad battery dies.
1.a. The enters the options tab
1.b. The user can press the exit button to leave at any time
3.a The user presses some other button by accident and turns on/off some other feature
3.b The user can undo this action by re-tapping the same button
d. The user can also press exit at any time to leave the options tab

Postconditions:
- None, the user can do nothing and just exit the options tab and the game will return to the board.
- Board returns to original state

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
5.1	5.1	Basic Flow: User taps the option tab	user is in the game	The options tab opens up for the player
5.1	5.1.a	Alternate Flow: the user closes the app or the ipad dies at any time		No changes are saved
5.2	5.2	Basic Flow: User taps on the sound options button		A list of sound options appear on the screen with on/off options
5.2	5.2.a	Alternate Flow: User clicks the wrong option button	user is in options tab	The incorrect option is chosen
5.2	5.2.b	Alternate Flow: Undo the wrong option by re-clicking		Goes back to previous state
5.3	5.3	Basic Flow: User taps on/off on sound effects option		The sound effects turn either on or off depending on its previous state
5.4	5.4	Basic Flow: The user taps the exit button to leave the options tab		The game returns to its original state

Use Case Name: Hints
ID: 6
Brief Description: Beginners will be greeted with helpful hints as to what their options are during different phases of play.
Actors: User, Other players
Preconditions:
- The app has been started

- A game is in progress

Basic Flow:
1. User taps on the options tab
2. `-> Options are presented to user on the screen and the game is blacked out`
3. User taps on the hints button
4. `-> The screen displays possible options for the player letting them know what they can do during that turn.`
5. User views the advice
6. User taps EXIT to exit the options tab

Alternate Flow:
- a. The user closes the app at any time.
- b. The game has an error at any time.
- c. The iPad battery dies.
- 1.a. The enters the options or hints tab
- 1.b. The user can press the exit button to leave at any time
- 3.a The user presses some other button by accident and turns on/off some other feature
- 3.b The user can undo this action by re-tapping the same button
- d. The user can also press exit at any time to leave the options tab

Postconditions:
- Board returns to original state

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
6.1	6.1	Basic Flow: User taps the option tab	user is in the game	The options tab opens up for the player
6.1	6.1.a	Alternate Flow: the user closes the app or the ipad dies at any time		No changes are saved
6.2	6.2	Basic Flow: User taps on the hint options button		The screen displays possible options for the player
6.2	6.2.a	Alternate Flow: User clicks the wrong option button instead of hint	user is in options tab	The incorrect option is chosen
6.2	6.2.b	Alternate Flow: Undo the wrong option by exiting		Goes back to previous state

6.3	6.3	Basic Flow: The user taps the exit button to leave the options tab		The game returns to its orginial state

Use Case Name: View Other Labs
ID: 7
Brief Description: The player can view any other player's lab during their turn to view their equipment, papers, and DNA.
Actors: User, Other players
Preconditions:
- The game has been started.
- It is a human player's turn.
- The lab contains at least one paper.

Basic Flow:
1 User touches other person's corner of the screen
2 `-> Screen displays overview of other person's lab.`
3 User touches the equipment tree.
4 `-> Screen displays a more detailed view of the equipment tree and the player's equipment`
5 User presses the exit button.
6 `->Screen displays overview of other person's lab again.`
7 User taps a paper.
8 `->Screen displays a details about the paper.`
9 User presses the exit button.
10 `->Screen displays overview of other person's lab again.`
11 User presses the exit button.
12 `-> Screen returns to the playing board`

Alternate Flow:
a.   The user closes the app at any time.
b.   The game has an error at any time.
c.   The iPad battery dies.
1.a.   The user doesn't touch another person's lab corner.
3.a.   The user doesn't touch the equipment tree.
3.b.   The user taps on a paper instead.
3.c.   The user presses the exit button.
7.a.   The user doesn't touch a paper.
7.b.   The user taps on the equipment tree instead.
7.c.   The user presses the exit button.

Post conditions:
- The screen is back to the game board.

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
7.1	7.1	Basic Flow: The player touches another player's corner of the screen		That player's lab will be displayed.
7.2	7.2	Basic Flow: The player touches the equipment tree.		The screen displayed a detailed tech tree showing what equipment that player has.
7.3	7.3	Basic Flow: The user presses the exit button.		The screen goes back to the lab screen.
7.4	7.4	Basic Flow: The user taps on a paper.	That player has at least one paper	That paper is displayed in greater detail.
7.5	7.5	Basic Flow: The user presses the exit button.		The screen goes back to the lab screen.
7.6	7.6	Basic Flow: The user presses the exit button		The screen returns to the game board and the player resumes their turn.

Use Case Name: View Tutorials
ID: 8
Brief Description: The player can view tutorials on how to play the game from the main menu.
Actors: User
Preconditions:
- The main menu is displayed.

Basic Flow:
1. User touches the tutorial button from the main menu.
2. ->The screen displays several different categories.
3. User touches a category.
4. ->The screen displays a screenshot and/or text describing an aspect of play.
5. User presses the "Next" button.
6. ->Another screenshot and/or text screen describing more appears.

7   User keeps pressing "Next" button until it no longer appears.
8   User presses the "Exit" button.
9   ->Screen returns to list of categories.
10   User presses the "Exit" button.
11   ->Screen returns to the main menu.

Alternate Flow:

3.a.   The user selects a different category.
3.b   The user presses the "Exit" button.
5.a.   The user presses the "Exit" button.
7.a.   The user presses the "Exit" button.
a.   The user closes the app at any time.
b.   The game has an error at any time.
c.   The iPad battery dies.

Postconditions:

● The screen is back to the main menu.

Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
8.1	8.1	Basic Flow: User touches the tutorial button.	The user is on the main menu	The screen will display several tutorial categories.
8.2	8.2	Basic Flow: User touches a category.		The screen displays a screen explaining that aspect of play.
8.3	8.3.a	Basic Flow: User presses the next button	There is more than one page for this tutorial	The next page of the tutorial is displayed.
8.4	8.3.b	Alternate Flow: The user presses the exit button.		The screen of categories is displayed.
8.5	8.4.a	Basic Flow: The user presses the next button.	There is another page of tutorial	The next page of the tutorial is displayed.
8.6	8.4.b	Alternate Flow: The user presses the back button.	It is not the first page of the tutorial.	The previous page of the tutorial is displayed.
8.7	8.4.c	Alternate Flow: The user presses the exit button.		The screen of categories is displayed.

8.8	8.5	Basic Flow: The user presses the main menu button.	The player is on the screen of tutorial categories.	The player is directed back to the main menu.

Name: View Learning Center
ID: 9
Brief Description: The player can educate themselves in various topics concerning synthetic biology through tutorials in the learning center.
Actors: User
Preconditions:
● The main menu is displayed.
Basic Flow:
1 User opens game options menu
2 ->The screen displays several different options
3 User touches the Learning Center Button
4 ->The screen displays the learning center menu with a list of topics to choose from
5 User clicks on one of the topics
6 ->The screen is redirected to the page for that topic, including embedded links to youtube.com videos
7 User reads about the topic to learn
8 User presses the "BACK" button.
9 ->Screen returns to list of topics.
10 User presses the "EXIT" button.
11 ->Screen returns to the main menu.
Alternate Flow:
1.a.   The user exits the Learning Center at any time
1.b.   The screen returns to the game
4.a   The user clicks the wrong link
4.b   Pressing the BACK button will return the user to the Learning Center menu
a.   The user closes the app at any time.
b.   The game has an error at any time.
c.   The iPad battery dies.
Postconditions:
● The screen is back to the main menu.

Test Cases

Test Case ID	Scenario	Description	Conditions	Expected Result
9.1	9.1	Enter learning center	User choose to enter "Learning Center"	"Learning center" Interface is displayed

		Choose topics to display	User choose a topic to explore	Each page regarding different topics is displayed, the links to youtube can be opened properly
9.2	9.5			
9.3	9.10	Exit the learning center	User choose to exit learning center	Upon user tap on the "back" button, the "learning center" interface exit to the main menu

Use Case Name: Ending a Game
ID: 10
Brief Description: After a game has been completed and a player has won, they are greeted with the option to return to the main menu or start a new game.
Actors: User
Preconditions:
- A game has just completed

Basic Flow:
1   -> Display end screen
2   User taps 'main menu' button

Alternate Flow:
> 2a1. User taps 'reset'
> 2a2. -> Reset game based on last game's settings

Postconditions:
- The ending screen is no longer displayed
- New game is created or Main menu is displayed

Test Cases

Test Case ID	Scenario	Description	Conditions	Expected Result
10.1	10.1	Basic Flow: User taps 'main menu' to return to the main menu from the end screen	The ending screen is displayed	Main menu is displayed
10.2	10.2	Alternate flow: User taps 'reset' button to restart the ended game	The ending screen is displayed	The game is reset with the same settings

Quality Attribute: Usability
ID:11

Source of stimulus: User
Stimulus: User attempts to leave the application by pressing the home button
Artifact: Application
Environment: User is a student in a classroom playing in normal conditions.
Response: The application remains in focus
Response Measure: The student can waste 0 seconds outside the application.
Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
11.1	11.1	Basic Flow: User presses the home button to return to the iPad main screen.	Single App mode is on	The application does not exit.
11.2	11.1	Basic Flow: User presses the home button to return to the iPad main screen.	Single App mode is off	The iPad home screen is displayed and the application remains in the application list

Quality Attribute: Usability
ID: 12
Source of stimulus: User
Stimulus: User touches something that takes more than one second for the system to
        respond.
Artifact: Application
Environment: Normal conditions
Response: The application shows that it is doing something while it is loading.
Response Measure: A spinning load icon will appear whenever an action will take longer than
one second to execute.
Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
12.1	12.1	Basic Flow: User loads a profile	Loading takes less than one second	The loading spinner is not displayed and it goes to the next screen as expected.
12.2	12.1	Basic Flow: User loads a profile	Loading takes longer than one second	The loading spinner appears until it finishes loading and then goes to the next screen.

* This is one scenario where this could happen, but this is representative any button pressed or action taken.

Quality Attribute: Usability
ID: 13
Source of stimulus: Color blind user
Stimulus: User wishes to be able play Biopioneer
Artifact: Application
Environment: User is color blind or deficient
Response: There is a color blind mode for the visually impaired.
Response Measure: A color blind user will be able to efficiently play a full game of Biopioneer with colors replaced by letters
Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
13.1	13.1	Basic Flow: User chooses the Color-blind view option in the options menu	Color blind options have not been turned on	The game colors change to color-blind friendly colors
13.2	13.1	Basic Flow: User chooses the Color-blind view option in the options menu	Color blind options have been turned on	The game colors return to the original colors

Quality Attribute: Performance
ID: 14
Source of stimulus: User
Stimulus: User presses any button
Environment: normal conditions
Artifact: system
Response: minimize time it takes for button clicks
Response measure: all button clicks are less than one second
Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
14.1	14.1	User taps any gameplay button		The game reacts to the users touch in less than one second

Quality Attribute: Reliability
ID: 15
Source of stimulus: Memory (game resources)
Stimulus: Long time running(50mins) (lots of game frames, info boxes)
Environment: Full 4 player playing a full length game for a long time(50mins)
Artifact: iOS sandbox
Response: The game should maintain running without memory overflow and jump out
          and crash.
Response measure: The game will remain running and game state is saved
Test Cases:

Test Case ID	Scenario	Description	Conditions	Expected Result
15.1	15.1	Users play the game for a long time. (More than 50mins)		The game should not exhibit any delay or crash, the game state should be saved
15.2	15.2	User returns to an old game still on the app list		The game state is properly loaded and playable upon opening

3.20 Test Cases Within the Prototype

A usability study was conducted in which 6 participants were asked to perform several tasks using the updated PowerPoint prototype of the BioPioneer application. These studies covered several of the use cases listed above. First users were asked to view the current profiles and create a new profile with given name and icon. This corresponds to test case 2: creating a profile. After creating a profile, users were then instructed to start a new game with 4 players. This action corresponds to test case 1: starting a game. Once users had navigated through the creation of a game, they were told to play a turn of the game by following on screen prompts. This corresponds to test case 3: playing a turn.

3.21 Usability Report

3.21.1 Process

We conducted our usability tests on October 23, 2012 in the usability lab. The purpose of doing this lab was to see how users would respond to the general layout and look of the

game so far. We also needed to see how easy our current prototype would be to use. We will use this information to better design our final product.

Six Rose Hulman students were selected for testing. The intended users of our application are high school students in a classroom setting and for personal enjoyment through playing the game anywhere. Being students, they closely resemble the intended audience although not as closely as we would have liked. They also were close to the other audience of casual players as most of them play touch screen games for fun. None of our participants actually owned and used an iPad regularly, and they are also a little older by a few years than the intended high school student that was intended, but they were still good subjects.

For the duration of the lab, Chris was in the room with the user providing instruction and help when needed. Spencer, Vismay, and Qin were in the computer room with Spencer running the computer and equipment. Using the lab allowed us to collected video and audio recordings of our participants. We made sure to have them sign informed consent forms because we were taking video of them and using the recording. Our usability tests consisted of six participants each completing the three main tasks of looking at and creating a profile, starting a new game, and playing a single turn of the game, as well as, some initial questions.

We started the test with some questions in a semi-structured interview. We asked them for some simple background information including their major, experience with iPad or other touch devices and how they used them. Questions about the main menu and the user's first impressions of the game and name were also asked. The questions were scripted out, but Chris asked follow-up questions based on their answers so that answers could be clarified especially if they pertained to improving the application.

After this short interview, we had the participants explore our prototype with some simple guided instructions given orally by Chris in the beginning and then through in game help tips after gameplay had started. First users were asked to view the current profiles and create a new profile with given name and icon. After creating a profile, users were then instructed to start a new game with 4 players. Once users had navigated through the creation of a game, they were told to play a turn of the game by following on screen prompts. We were able to get plenty of good qualitative information from observing them while they played the game. Participants were asked to think out loud during their play through. This helped us see when they were confused and when the prototype was doing well at helping them along. In the controlled setting of the usability lab, Chris sat across from them and helped them whenever they needed it or asked questions. We directly recorded what they pressed on the screen as well as a top-down view of their hands playing the game.

After they were finished with the prototype, we asked them to fill out a questionnaire. This included three questions using the Likert scale and two open-ended questions. These were helpful in collecting some quantitative data using the Likert questions as well as qualitative data concerning what they thought of the experience and improvements that they would recommend.

3.21.2 Analysis

Observation of the participants and the recording led us to a several key observations. Many of these had to do only with the current prototype, but a few were valuable insights that we will be sure to use in the final implementation.

Several positive aspects of the prototype were noted. All participants were able to make it through the tutorial with little or no help. The tutorial tips during gameplay were a success as several people noted in the questionnaire and in the their comments during the test. Most of the confusion did not come from a usability standpoint but from not understanding how the game worked and from the inflexibility and lack of options in the limited prototype.

Many users did have problems getting the buttons in the game respond though. This was because the prototype had a slight bug in it. Pictures and words on top of buttons could not be clicked in the current prototype. While this was a bug in the prototype, it led to a realization that will critical to the final project. All of the users pressed the buttons right where the words or pictures were. For the final app, all words and pictures on buttons must be clickable, as that is where the user is going to push to activate the button.

This was especially true on the plus and minus arrows for adjusting the roll using a pipette. These buttons were small and the pictures took up most of the button. From users trying these buttons out, it was determined that these buttons need to be made bigger, or moved in a way that is more user friendly.

A lot of confusion came from users not understanding the actual game mechanics. The tips in the game were useful to players by letting them know what to do, but they did not help them know how the game actually worked or why they were doing what they were doing. This was important to see as it is now clear that we need to have more information on how the game works and the reasoning behind actions so that players will learn how to play the game better.

This lack of information brought to our attention a specific detail about the lab selection screen. User number 2 asked what the different labs were and if there was a difference. Although they did not have a choice in the current prototype, the different labs do correspond to different abilities that the player has. To accommodate for this, the lab selection screen was discovered to need information on the differences between labs and the abilities gained by choosing that lab.

The confusion of how to play the game brought attention to another problem with our design. Several players who used the pipette were not sure why they would want to. Although this was mainly due to the fact that they did not know how to play the game, it also let us know that the game board could not be seen while using a pipette. In order to effectively use the pipette, a view of the game board is necessary to see whether the player should move forward or backward. The equipment screen needs to be redesigned to allow users to see both the pipette and the game board.

Questions about the main menu were asked at the beginning of the usability lab. While all of the users thought the main menu was straight forward and made sense, many were confused by the name of the game. The name BioPioneer did not explain what the game really was or what it was about. This led the suggestions of changing the name or adding a subtitle below the name to help explain what the game really is. Also, many users thought that the main menu, as well as, other backgrounds needed to be more exciting and flashy.

Overall, people were able to effectively use the prototype. Several problems hindered them a little, but never stopped them from completing the task. It provided some good insights that will be used to make the final product much better.

3.21.3 Field Study

We were unable to conduct a proper field study of our project given the fact that our project is geared towards high school students learning about biology. Since we did not have access to the proper demographic for the field study, we chose to use random students at Rose Hulman to conduct our field study. These were our conditions for the field study:

1. The users had to use a mouse instead of touchscreen because the laptop that was used did not have a touchable screen.
2. The users needed to be able to go through the entire game scenario without any help (unless absolutely necessary).
3. The users would not be interrupted, but information about their progress were collected sitting beside them and taking notes.
4. The user would speak aloud his internal dialogue while conducting the test.

The field study gave us results very similar to the usability test. We found that the in-game hints, though still incomplete, helped the users quickly understand the overall premise of the game. The users appeared to be happy about the layout of the interface. They found it to be easy to understand and use. I also received positive feedback on a game tutorial in addition to the in game hints.

There were some places where the users had trouble playing the game.The users seemed to have trouble with selecting a user, but that was due to the layout of our power point. Users had to select a predetermined player, they could not choose their own.

The only difference in the results between the field study and the usability test was the amount of data. In the field study, we could not watch a video of the participant and rewind to find things we missed. The usability lab gave us a more structured approach to the testing, but the field study gave us a more realistic approach.

3.21.4 Findings

These are the results from the questionnaire. The answers to the first three questions were assessed using a Likert scale. The rest were open answers:

1. On the first question, three of the six people surveyed said that our user interface needs improvement. The other three people on the survey said that our interface design was good.
2. On the second question, three people said that our in game hints were good. This distribution was more varied here because one person said that our hints needed improvement, while the other two said that they were excellent.
3. On the third question, four of the six people surveyed rated the usability of our game as good, while one listed the usability as OK, and the other listed it as excellent.
4. On the written questions, we found that the thing that people found appealing about the game was the in-game hints. The hints apparently "helped with understanding the rules of the game." The bright colors also helped us in the usability factor.
5. The testers wrote that the imperfect touchscreen on the IBM laptop detracted from the overall effectiveness of the prototype. We also noticed that the testers demanded a

tutorial just in case they didn't understand the instruction on their first time through the game.

Additional analysis was able to be gathered after the tests happened using the OVO software. The video and audio recording were examined, the recordings were split into the individual tasks that the users completed, and comments were entered after each section was completed. This allowed the similarities and differences between users to become clear. This information, as well as others, were placed into the OVO reporting tools. This report provides useful quantitative data on the time it took users to complete the tasks, providing the mean, minimum, maximum times and the percentage of times each task was completed successfully with and without help. The tables generated by the report are included below.

Task Details

01 Open

User ID	Task Time	Task Resolution	Comment
02	1:26	Successful	Civil. Has an iPhone and uses social media apps. Main menu looks simple. Guessed it was game.
03	1:49	Successful	Chem. Has a Kindle and plays games (Angry Birds). Main menu was straightforward. Was curious about name but didn't know what it meant.
04	2:01	Successful	Chem. Uses an iPad regularly to play games (boat game). Guessed it was a game like Oregon trail based on Pioneer with something to do with Biology
05	1:48	Successful	Wanted to explore the menu right away. SE. No apple products. Does play games on touch devices though. Wanted all of the menu buttons to work. Guessed it was a game to do with biology and maybe pioneering but wasn't sure.
06	1:51	Successful	CS. iPhone and uses facebook and fruit ninja. Guessed was a game, but didn't know what kind of game but thought it might be educational from learning center. Thought it might be good to explain what the game was on the menu.
Mean	**1:47**		

Values:	(mm:ss)		

02 Profiles

User ID	Task Time	Task Resolution	Comment
01	0:56	Successful	Knew to click on profile. Went straight to create a new profile. Tried to change things, but was limited by prototype. Never tried to click on profiles (might not have been obvious that they showed anything).
02	1:03	Successful	Tried on profiles and was surprised at the result. Immediately tried to insert picture. Seemed fine with everything else.
03	0:33	Successful	Clicked on profiles and went quickly through the profile creation acting like he understood what to do.
04	0:50	Successful	Clicked through profiles and found bug with profile names. Did everything quickly.
05	0:57	Successful	Clicked on profiles and made a profile without issue.
06	0:40	Successful	Clicked on profiles and was surprised by result. Created a new one and tried to make another but couldn't
Mean Values:	**0:50 (mm:ss)**		

03 New Game

User ID	Task Time	Task Resolution	Comment
01	1:42	Successful with Assistance	Was a little confused during the player selection mainly due to the limited options presented by the prototype. Tried to click individual dice on roll screen.
02	1:23	Successful	Asked about prototype functionality and then

User ID	Task Time	Task Resolution	Comment
			sped through creation. Clicked roll all first right away. Was interested in the actual labs.
03	1:03	Successful with Assistance	Thought that the numbers of players meant they were guests. Was confused that they couldn't use profiles. Went quickly after that though.
04	1:17	Successful with Assistance	Wanted to use custom options for players. Tried clicking on individual dice and didn't immediately see roll all. Went through the rest quickly.
05	1:12	Successful	Wanted to use his new profile. Was a little confused with the using all guests. Went straight to roll all. Went quickly through the rest.
06	1:39	Successful	Wanted to use his new profile. Tried to click each dice and then moved to roll all.
Mean Values:	**1:22 (mm:ss)**		

04 Play Turn

User ID	Task Time	Task Resolution	Comment
01	2:40	Successful	Started to play without any instruction from Chris. Didn't try an ability. Help tutorials actually helped when read. Tried to tap on DNA sequence in lab view. Had problem clicking on die to get person because prototype didn't respond with no feedback.
02	2:59	Successful	Didn't know about what abilities were or what they did. Used one because we told him to. Clicked directly on the pipette and prototype didn't respond. Didn't know why he would want to change his roll. Followed the help screens. Didn't know what to do with lab view screen, but was ready the next time it came up. Started to try and understand the game based on the tutorial.
03	1:36	Successful	Had problem clicking on the die, but kept trying. Didn't use an ability, wanted to save it. Went quickly through the rest following the help bubbles.

04	1:35	Successful	Ability seemed too complicated so didn't use. Went quickly through the rest and seemed to be able to follow the instructions
05	2:35	Successful with Assistance	Took action was didn't understand what it did. Tried clicking directly on the pipette. Wasn't sure what to do after changing his roll. Understood and accepted it the next time (rolling for a person)
06	2:10	Successful with Assistance	Had to hit roll twice. Took an action voluntarily. Had troubled clicking the up and down areas. Tried clicking on the lab view. Had trouble again with the roll the second time. Wanted to use another ability.
Mean Values:	**2:16 (mm:ss)**		

Task Summaries

Task ID	Mean Time mm:ss	Minimum mm:ss	Maximum mm:ss	Task Resolution	Frequency
01 Open	1:47	1:26	2:01	Successful	6
02 Profiles	0:50	0:33	1:03	Successful	6
03 New Game	1:22	1:03	1:42	Successful	3
				Successful with Assistance	3
04 Play Turn	2:16	1:35	2:59	Successful	4
				Successful with Assistance	2

All participants were able to complete the tutorials with little or no help. Most users had trouble with the limited nature of our prototype and with not understanding how to play our rather complex game. Overall the tutorial tips were helpful and let the player complete what was needed. Some problems with the touchability of some buttons caused problems for several participants.

3.21.5 Presentation

Presentations will take place in two settings. The first presentation will be given to the Requirements Engineering class and will highlight the procedure and major findings of our usability study. The second presentation will be given to the client and will demonstrate how the study was conducted as well as what aspects of the application were found to be successful or inadequate. Video highlights that demonstrate users interacting with our prototype will accompany both presentations.

3.22 Interaction Architecture

The interaction architecture for the prototype used in the usability lab consisted of a PowerPoint with hyperlink actions inserted into buttons to simulate touchable screen items. In order to simulate a touch interface, a junior student's Lenovo laptop was used, with which users could tap the screen as if using an iPad. The specific architecture paths are detailed below the PowerPoint slides in Appendix A.

3.23 Initial Interface Design

When writing use cases for a previous Milestone, there was much discussion amongst the development team as to which was the correct way to approach certain features of the application. It soon became clear that the need for a standardized game model was in order. This was the beginning of the prototype used during the BioPioneer usability lab. From its origins, the prototype has been focused on satisfying the major use cases, and subsequently test cases, described in the previous sections.

Keeping in mind the fact that it was to be a throw away prototype, the team decided to focus on only certain aspects of the application, rather than going into depth about the Biopioneer game. Users would have the ability to view and create a new profile, start a new game, and play a turn. Given the time constraints placed upon the team to develop the prototype, PowerPoint was selected as the most appropriate prototype format. This would give the users the ability to navigate all the available screens and would require no actual programming. The drawback of a PowerPoint was its lack in flexibility. For the majority of the time, users were required to follow built in scenarios rather than exploring the application for themselves. Rather than focusing on flexibility and users' understanding of the game, the goal of our usability study was to assess user's reactions to the look and design of the system.

When developing our prototype, we gave particular thought to the design principles of Visibility, Feedback, Constraints, Consistency, and Affordances. We wanted to ensure that all the user's options are visible to them and that each action they made prompted some response from the prototype. At the same time, in order to reduce clutter and improve the clarity of the application, we wanted to give users a constrained set of options for each situation. The game was given internal consistency by making all buttons and windows of similar look and feel. In addition, it was very important that the game be externally consistent with the original board game. Finally, formatted buttons would be used tell users which items were touchable and which were not.

In order to create a proper representation of the final product, special attention was given to the appearance and usability of the prototype. Using a PowerPoint platform allowed the team to easily and quickly create a quality GUI that would be representative of the final game. In

order to aid the users through the steps of the usability test, the final piece added to the prototype was in game hints that would provide user instruction. In this way the prototype was able to test not only visibility and usability, but also the understandability of one of the game's most important features.

3.24 Revised Interface Design

Though many hours were invested into creating the usability lab prototype, it is far from perfect. Certain flaws in our design could only be uncovered through analysis of the results of our usability lab. Through our observations we were able to identify several key issues that must be addressed in future models of the system:

- Buttons and the images on buttons both need to be touchable
- Change +- buttons for pipette
- When choosing labs, a description should be included
- Include a subtitle on the main menu, or change the game's name
- Improve visibility when menus are displayed
- Future prototypes should be more flexible
- More interesting background
- Include tutorials in next prototype

There were several instances in which users would press on a button's overlayed image and expect a result that did not occur. We must ensure that the both the buttons and any images covering them be touchable to produce the same result. Certain buttons, in particular the + and - buttons for changing the result of a die roll, were slightly too small to be easily pressed. These buttons should be made larger in the next prototype. When starting a new game, it was unclear what decision making process should be used when choosing starting lab. To rectify this, the lab starting equipment and such should be visible when selecting labs. One aspect of the application that we had not given much thought was the title. Users seemed to be thrown off by the name Biopioneer. Some thought the game was about pioneers, others about biology. One user suggested adding a subtitle to describe the nature of the game. Another problem with the GUI occurs when users are adding to or subtracting from their die roll. While the pipette info box was displayed users were unable to see the game board to know which number they wanted on the die. Changing this menu would improve visibility of the pipette feature. One complaint about our prototype was the lack of flexibility and freedom given to the users. This reaction was anticipated and was the main drawback of using a PowerPoint. Future versions of the system will include a more flexible game. Due to the complexity of the game and shallow nature of the prototype, users often felt overwhelmed by the different options available to them and were unsure what the proper course of action was. In future versions of the system, tutorials will be available to introduce users to the game. The final issue uncovered through user testing was a lifeless background. We had thought that a simple background would represent a minimalist element in our project, but user opinion demonstrated that this is unnecessary. A more interesting background will be added to later releases.

Those changes that could be made cost effectively (highlighted) were implemented into the prototype and are visible in Appendix B.

4. References

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5. Appendix

5.1 Appendix A: Initial Interface Design
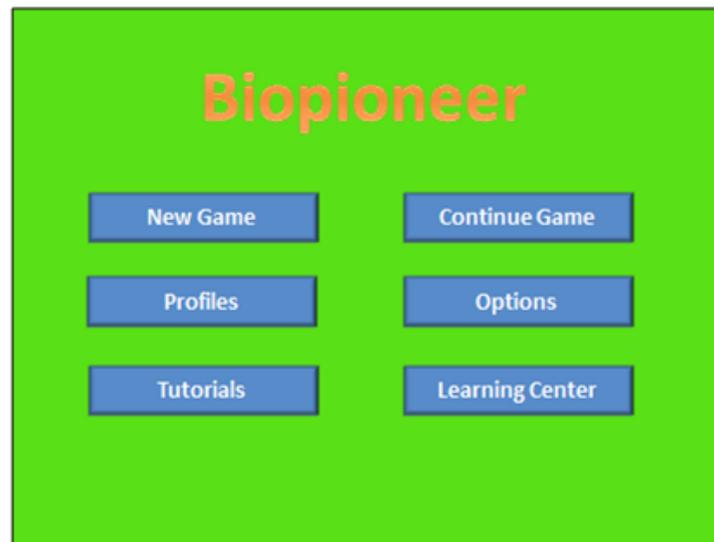
Slide 1: This is the main page for the Biopioneer application. The user may start a new game (slide 9), continue the previous game (slide 29), view the profiles menu (slide 2), change the options, access the tutorials, or view the learning center.

Slide 5: This is the profiles menu. From here users can tap on a profile to see stats for the player selected, create a new profile by tapping the 'new...' button (slide 3), or tap back to return to the main menu (slide 1).
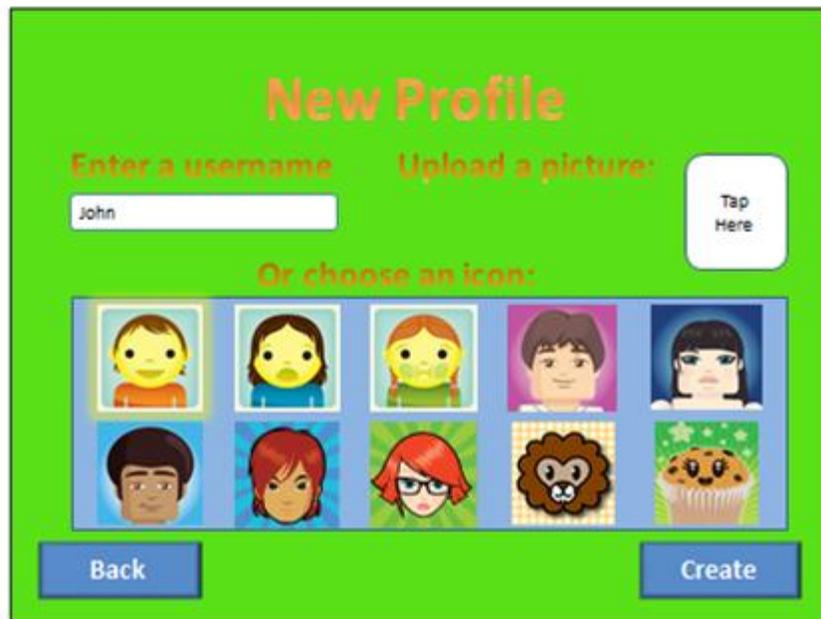
Slide 3: This is the screen players are greeted with when they create a new profile. In our prototype users can only tap 'back' to return to the profile menu (slide 5) or 'create' to finalize their new profile (slide 5).
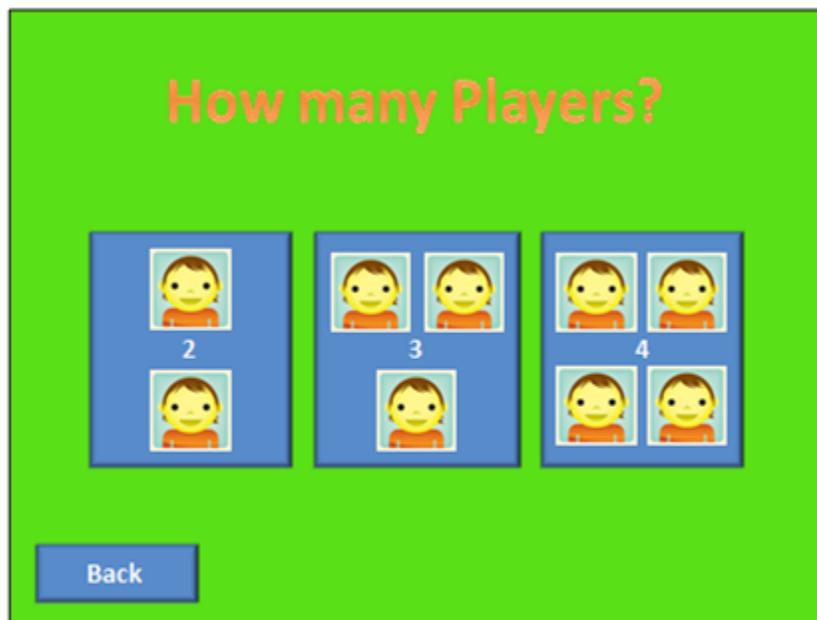
Slide 9: The first thing users must do when starting a game is select the number of players. In our prototype users must select 4 players. Tapping the four player button will continue the game creation procedure (slide 10). Tapping back returns the user to the main menu (slide 1).

Slide 10: After the number of players has been selected, then each player takes turns picking whether to use a profile or play as a guest. In our prototype all players must be a guest. Users may tap the guest button to continue the game creation (slide 11) or back to return to the previous screen.

Slide 11: If electing to play as a guest, users are then allowed to choose an avatar and name to represent them in the game. For our prototype users could tap 'back' to return to the profile selection screen (slide 10) or 'continue' to allow the next player to choose a profile or avatar (slide 10). Once all players have chosen, tapping 'continue' will take users to the rolling stage (slide 18).
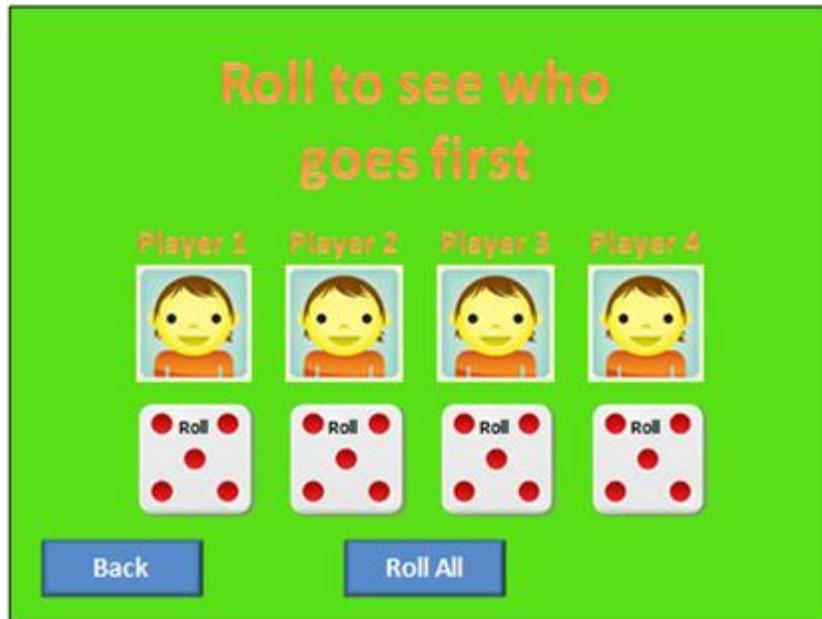
Slide 18: After all players have selected a profile or avatar, they must roll to decide who goes first. In the real game users can each tap on the die to roll. In our prototype users have the choice to roll all the dice using the 'roll all' button (slide 19), or tapping 'back' to return to player 4's avatar selection (slide 11).

Slide 19: After all the dice have been rolled and the play order has been determined, users must press 'continue' to progress to the token and lab selection stage (slide 20).
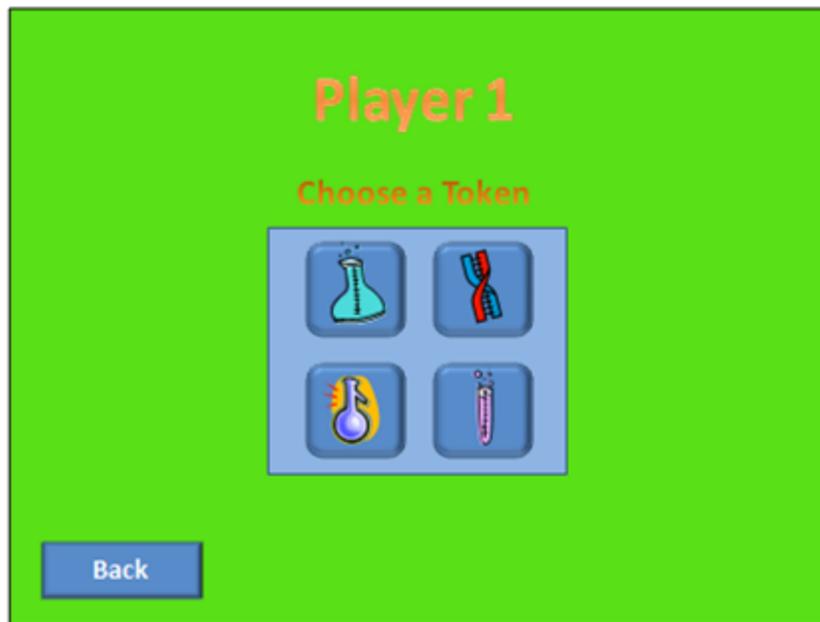
Slide 20: The players take turns choosing a token to represent them on the game board. Users may tap on a token to progress to the lab selection phase (slide 21), or on 'back' to return to the previous screen.

Slide 21: After choosing a token, users are then required to choose a lab. Users may tap on a lab to progress to the next player's turn (slide 20), or 'back' to return to the previous screen. Once the last user chooses a lab, the game displays the game length screen (slide 28).
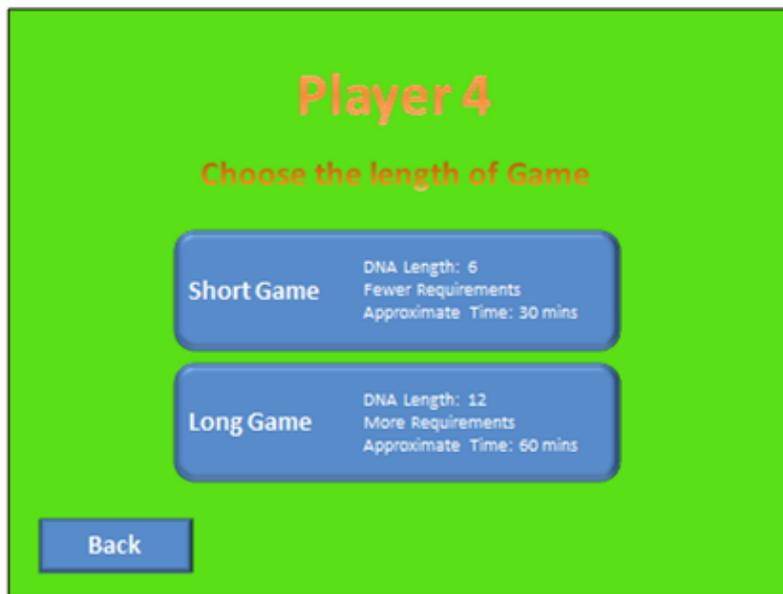
Slide 28: After all players have chosen a token and lab, they must decide the length of the game. In our prototype users must choose a short game. Users may tap on the short game button to start a short game (slide 29), or 'back' to return to the previous screen.
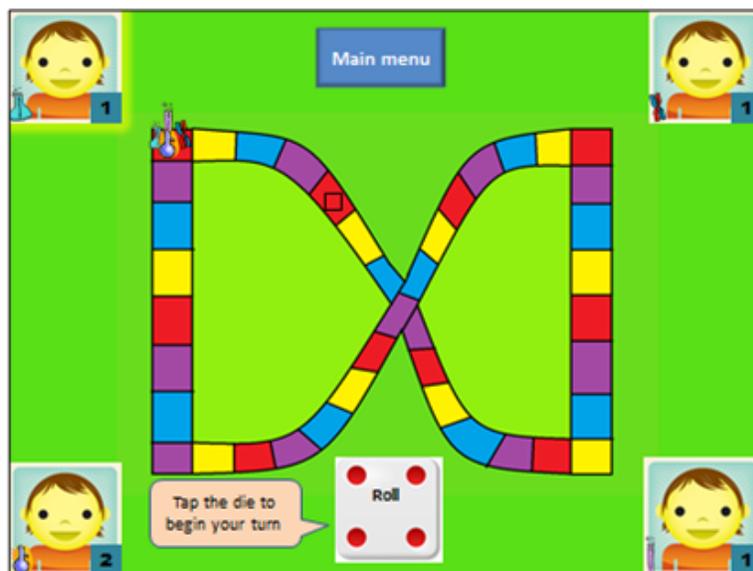
This is the screen a player would view if it were the first turn and the first player is about to roll. In game hints will be used to aid users who are new to the game. The user may return to the main menu by clicking the main menu button, view any player's lab by clicking on the corresponding picture, or roll the die to move. In the prototype, a user may tap the main menu button (slide 1), or the die to start their turn (slide 30).
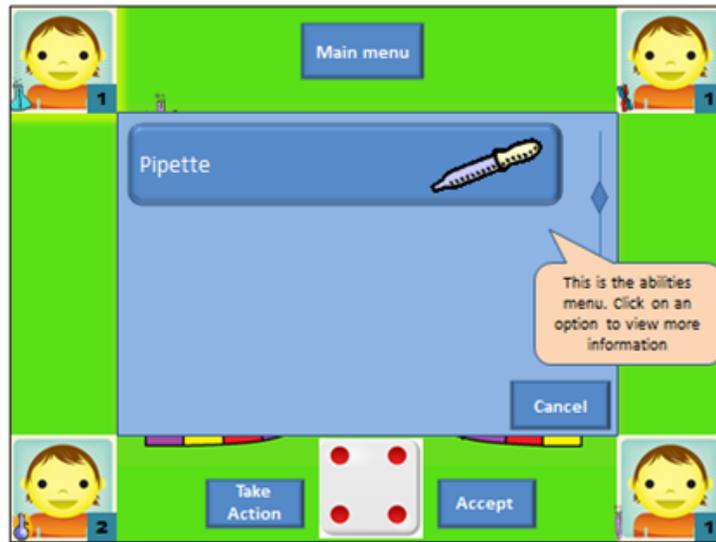
Slide 31: This is the abilities menu presented to users that wish to change the result of a rolled die. Users can return to the main menu, choose a pipette, accept their roll, or close the window with 'cancel'. In our prototype users may tap 'main menu' to return to the main menu (slide 1), 'pipette' to display the pipette window (slide 32), 'cancel' to remove the abilities menu (slide 30), or 'accept' to move 4 spaces (slide 35).
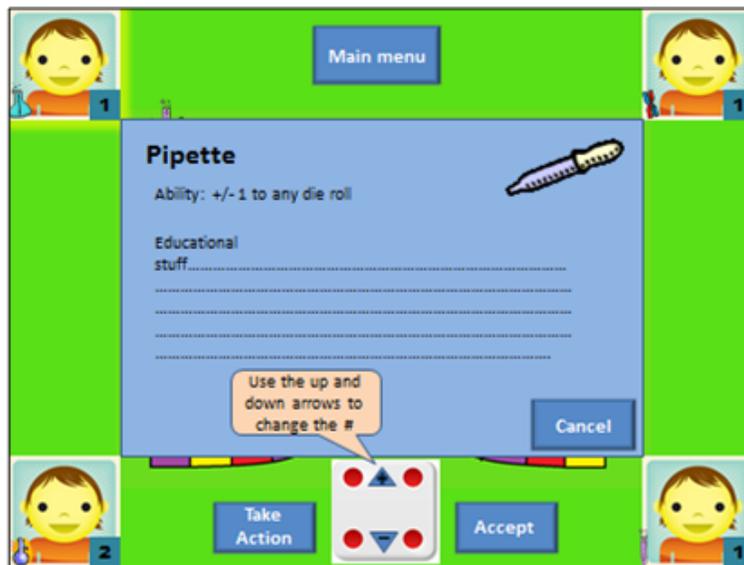
Slide 32: Once users have opened the pipette window, they may increment or decrement the number on the die by 1. In our prototype users may tap 'cancel' to return to the abilities menu (slide 31), the '+' or '-' buttons to change the number on the die, or 'accept' to accept the number on the die at that time (slide 35).
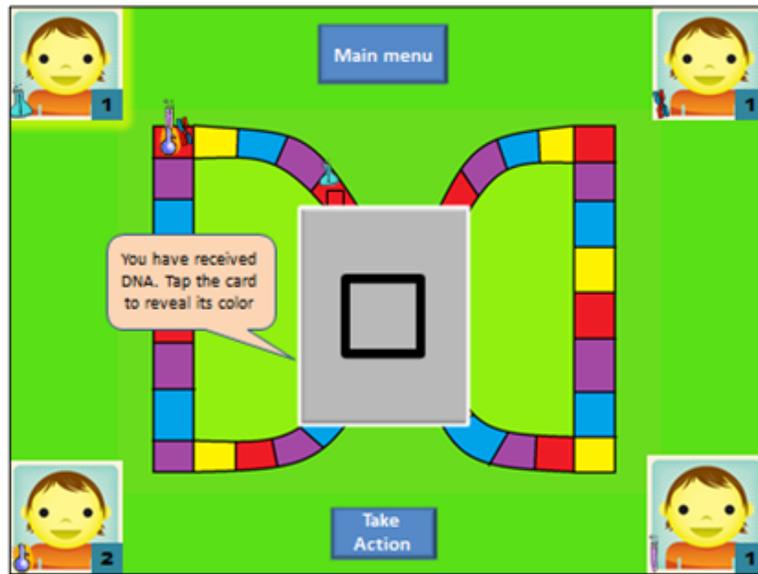
Slide 35: The user's piece moves spaces and lands on a space. A card is then shown corresponding to the shape the user landed on. The user can either tap the card to flip it and reveal the DNA, or use an ability to expand his options. In our prototype users main only tap 'main menu' to return to the main menu (slide 1), or tap the card to reveal its color (slide 36).
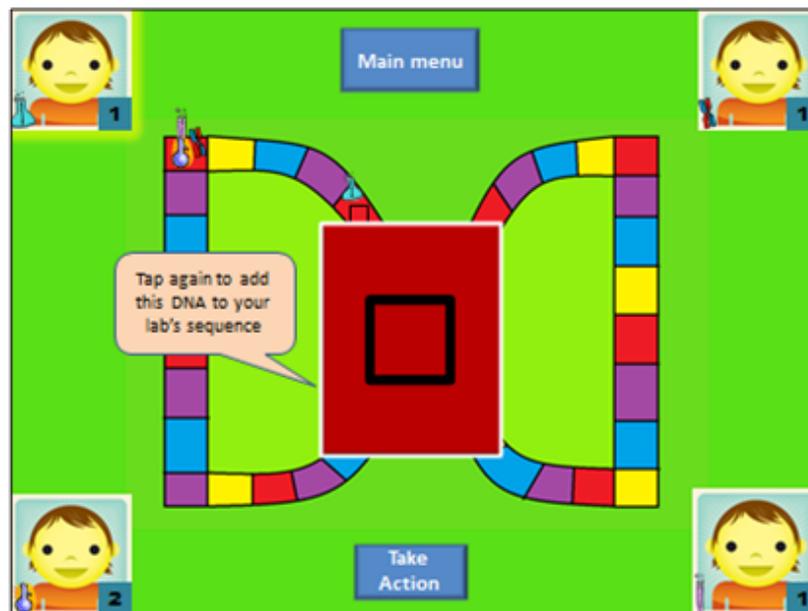

Slide 36: Once tapped the card is flipped to reveal its color. The user may either tap the card to accept it or tap 'take action' to use an ability and change the card. In our prototype users may only tap 'main menu' (slide 1), or the card to collect it (slide 37).
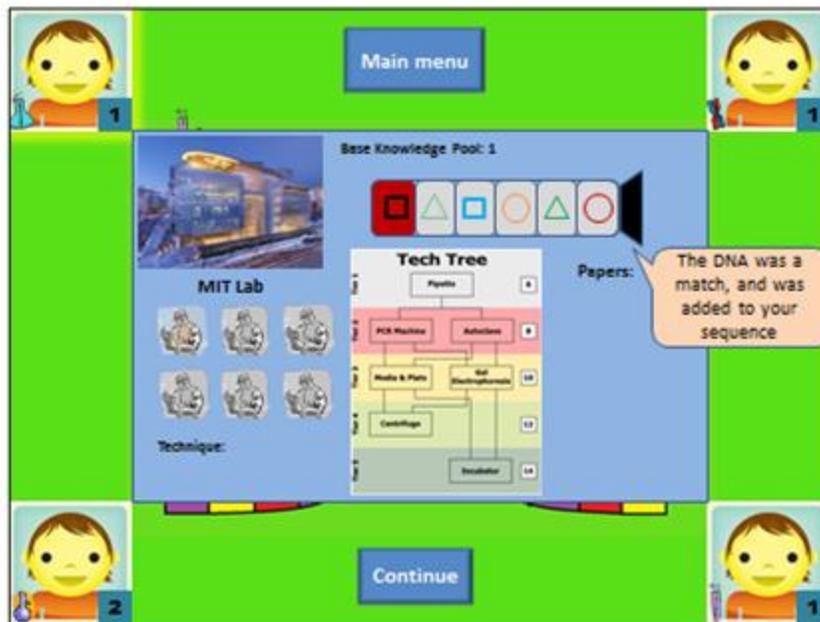
Slide 37: If the card received happens to fit into the next spot in the user's DNA strand, then it will fill the tube, otherwise it will be rejected. The user then taps 'continue' to continue their turn (slide 38). The main menu button will return the user to the main menu in any circumstance (slide 1).
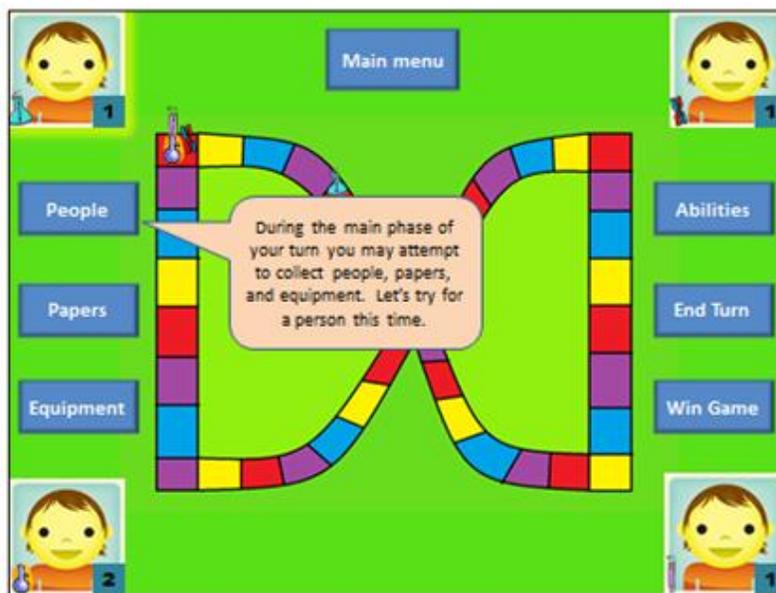

Slide 38: During the main phase of the turn the user is able to acquire people, papers, or equipment, use their abilities, end their turn, or attempt to win the game by solving the world problem. The user's actions are shown in the blue box in the corner of their picture. In the prototype users may only tap 'people' (slide 39).
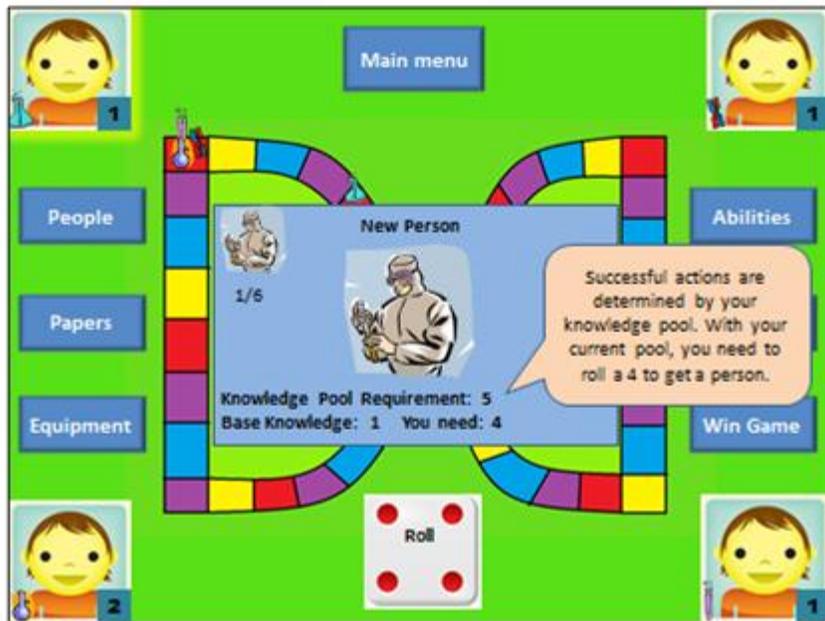
Slide 39: After choosing to go for a person, the user is greeted with a screen which displays what roll the user needs to acquire the next person. The user may roll to use an action and attempt to get a person. They may also back out of the person screen by clicking on any of the options around the edges of the screen. In or prototype users must tap the die to roll (slide 40).

Slide 40: If the user rolls, they may either accept their roll, or adjust it using an ability. In our prototype the user must accept the 4 (slide 41).
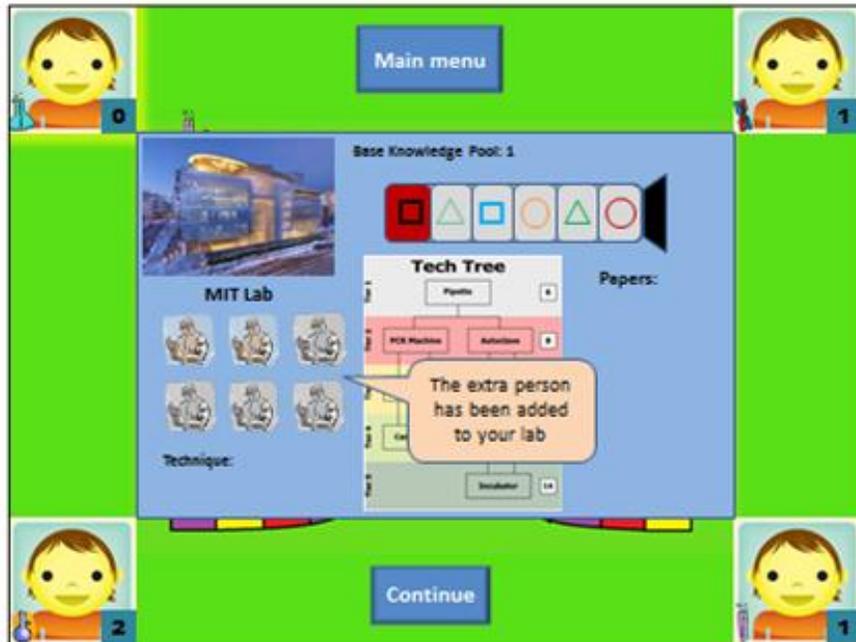
Slide 41: If the user has a sufficient knowledge pool, they will receive the person in their lab. They may tap 'continue' to continue their turn (slide 42).
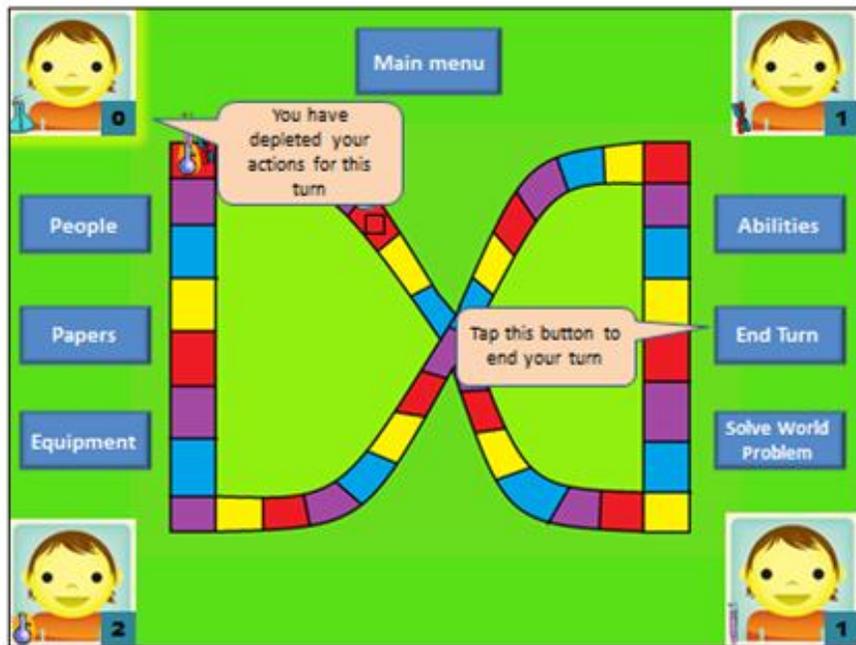
Slide 42: Once a player runs out of actions, their only option is to end their turn. They do this by tapping the end turn button (slide 43).

5.2 Appendix B: Revisions to Interface

This is the main page for the second version of the Biopioneer prototype. Notable improvements include a more interesting background and leading subtitle.

This is the lab selection screen for the second version of the prototype of Biopioneer. Notable improvements include descriptions of each lab for users to view when choosing. In addition, when pictures are tapped, they will case the same action to occur as if the button itself were tapped.
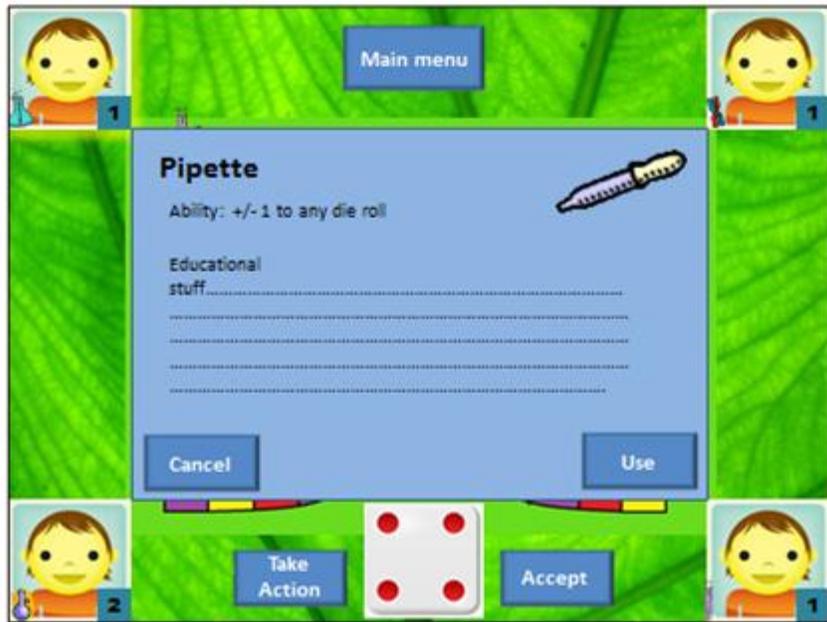
This is the pipette window for the second version of the prototype for Biopioneer. The most notable change is the inclusion of a "use" button that must be pressed before users may increment or decrement their roll.

This is the pipette use screen for the second version of the prototype for Biopioneer. Notable improvements include the increase in size of the '+' and '-' buttons, in addition to the ability to view the game board while changing the die roll.

5.3 Appendix C: Usability Study Consent Form

Project Title	Biopioneer iPad Application
Why is this research being done?	This research is being done by the developers of the Biopioneer application in order to measure the usability and overall user experience of the Biopioneer game app.
What will I be asked to do?	As a participant in the study, you will be asked to experiment with a prototype of the Biopioneer iPad application. Specifically you will be starting a game and playing through a turn of the Biopioneer game. You will be observed in order to gauge your progress and understanding of the application. After your experimentation has concluded, you will be asked to complete an interview with one of our evaluators about your experience with the prototype.
What about confidentiality?	Your identity will at no point be recorded without consent. You will receive a subject number and this will identify you through the course of the study. During the observation portion of the study, some user interactions may be recorded on video cameras. If you are willing to be videotaped playing the Biopioneer game, then all recordings will be retained by the developers of the application and will at no point be released to the public. Please check the appropriate box below: ☐ I agree to be videotaped during my participation in this study ☐ I do not agree to be videotaped during my participation in this study
What are the risks of this study?	There are no known risks associated with participating in this study.
What are the benefits of this research?	The aim of this study is to enhance the user experience and overall quality of the final Biopioneer application.
Do I have to be in this research? May I stop at any time?	Participation in the study is completely voluntary. Participants may elect to stop playing at any point and may opt out of the exit interview. In the event that a participant leaves the study, they will be given the option to allow or disallow the completed portion of their session to be used in the study.
What if I have questions?	All questions regarding the study can be directed to the development team representatives at hoorncj@rose-hulman.edu
Statement of Age of Subject and Consent	By signing below you are submitting that you are at least 18 years of age and freely and voluntarily choose to participate in this study.
Signature and Date	Name: _____ Signature: _____ Date: _____

5.4 Appendix D: Questionnaire

Please take a moment to answer the following questions truthfully. Circle the answer that best describes your opinion.

1. How would you rate the look of the application prototype you just played?

Awful   Needs Improvement   OK   Good   Excellent

2. How helpful were the in-game hints to your understanding of what to do?

Awful   Needs Improvement   OK   Good   Excellent

3. How would you rate the usability of the game?

Awful   Needs Improvement   OK   Good   Excellent

4. Tell us one or more things you liked about the application you just tested.

5. Share with us one or more problems with the application or suggestions you have.

Thank you very much for your cooperation. Team Biohazard appreciates your help.

5.5 Appendix E: Test Script

BioPioneer

Open up the BioPioneer App on an Ipad

Before we begin, there is some information that I need to cover with you, and I'm going to make sure to cover everything first. Today we're asking people to try using an iPad app we're working on called BioPioneer so that we can see whether it works as we intend it to or not. This usability test should take about 20 minutes.

You should not worry about making mistakes because it is the app that we are testing, not the participant. While using the app, I would like you to think out loud as much as possible to give us a better idea of your thinking and your reactions to the app. We need to hear your honest reactions.

If you have questions, you should ask them, but we might not answer them because we are interested in how participants interact with this game without an "expert" to help them along. While you are using the app, we will record your reactions and your game play using this video camera.

Before the testing begins, I must ask you to sign this Non-Disclosure Agreement and the permission form to record your reactions.

Give them the NDA to sign.
Give them the permission form to sign.
Start the recording.

Do you have any questions?
If you don't have any questions, would you mind me asking some?

1 What is your occupation?
2 How much time do you spend on an iPad everyday?
3 What do you usually do on the iPad?
4 What type of apps do you usually use?

Ok, now I'm going to show you this page (the Menu Page), tell me what you think.
1 What are most likely to click on this page?
2 What type of app do you think this is?
3 Who do think made this app?
4 What purpose does this app serve?

Now, we're going to ask you to do some specific things.

First, take a look at the profiles menu. Explore the current profiles and create a new one. Then, go back to the main menu.

Next, start a new game with four players. As this is trial test, all players need to be set as guests with the default name and picture. Continue through the game initialization knowing that the options on tokens and labs are preset and must be chosen correctly to move on.

Now that the game has been started, start your turn by rolling die. Follow along with the in-game tutorials until you've reached the end of the turn.

Give them the first scenario to work with.
Take notes.
Allow them to proceed until you feel nothing more can be learned from continuing.
Repeat this with multiple scenarios.

If there are no last minute questions, then we're done. Thanks for participating.

Stop the recording.

5.6 Appendix F: Biopioneer Rulebook

Goal of the Game

The goal of Bio-Pioneer® is to solve the World Problem through the use of synthetic biology. To do so, your lab must achieve all prerequisites of the World Problem, synthesize your DNA sequence, and reach the Knowledge Pool Requirement of the World Problem.

Game Set-Up

Remove all pieces from the box. This should include:

- 1 Game Board
- 1 6-sided Die
- 5 Lab Player Mats
- 6 World Problem Cards
- 12 DNA Sequence Cards
- 13 Blue Triangle, Square, and Circle Shape Cards
- 13 Red Triangle, Square, and Circle Shape Cards
- 13 Green Triangle, Square, and Circle Shape Cards
- 13 Orange Triangle, Square, and Circle Shape Cards

- ·   12 Lab Event Cards
- ·   4 of Each Equipment Card including:
  - o Pipette
  - o Media & Plate
  - o Gel Kit
  - o PCR machine
  - o Autoclave
  - o Centrifuge
  - o Incubator
- ·   30 Lab Personal Cards
- ·   15 Scientific Paper Cards
- ·   4 Lab Tokens
- ·   4 Triangle, Square, and Circle Shape Changing Tokens
- ·   3 Blue, Red, Green, and Orange Color Changing Tokens

Each player selects the lab of their choice. Every lab has a unique technique found in synthetic biology so select one that fits your play style. If multiple people want the same lab, each player must roll the 6-sided die. The player with the highest number gets the lab. Each player then collects the starting resources found on their Lab Play Mat and places their Lab token on the start location of the game board.

Starting the Game

To determine who goes first, each player will roll the 6-sided die. The player with the highest number will go first and play will pass to his/her left. There are 6 total World Problem events, 3 designed for a short game and 3 designed for a longer game. Randomly select the World Problem Card for the game type preferred.

Taking Your Turn

A turn consists of the following phase:

1) Movement and Shape Card Selection Phase
2) Lab Personal & Equipment Phase
3) World Problem Phase

Movement and Shape Card Selection Phase

To start off the turn, the player rolls the 6-sided die. The player then moves the number of spaces that appears on the die. There are 5 types of spaces in the game:

When a player lands on a square space, they must take a card off the top of the Square Shape Card Pile. The player then has the choice of keeping the card to add to their sequence or discard the card, placing it adjacent to the Shape Card Pile.

When a player lands on a triangle space, they must take a card off the top of the Triangle Shape Card Pile. The player then has the choice of keeping the card to add to their sequence or discard the card, placing it adjacent to the Shape Card Pile.

When a player lands on a circle space, they must take a card off the top of the Circle Shape Card Pile. The player then has the choice of keeping the card to add to their sequence or discard the card, placing it adjacent to the Shape Card Pile.

When a player lands on a star space, they may choose what Shape Card Pile they draw from. The player then has the choice of keeping the card to add to their sequence or discard the card, placing it adjacent to the Shape Card Pile that they selected.

All players must stop when they pass a lab event space. They then draw one card from the Lab Event Card stack and follow the instructions on the card.

Lab Event Cards

The goal of lab event cards was to make the game more realistic from a synthetic biology stand point. The lab event cards are based on natural phenomena that may happen when working in the lab, some being a benefit to your lab and others a detriment. If you go through the entire Lab Event Card Pile, shuffle the discard pile and draw the top card.

Aseptic Technique – Your lab has used proper Aseptic Techniques. Pick one shape card from any Shape Card Pile. You may keep the card to add to your sequence or discard the card, placing it adjacent to the Shape Card Pile. Place this card in the Lab Event Card Discard Pile.

Equipment Malfunction – One of your pieces of equipment experienced a malfunction. Randomly select one piece of equipment. You cannot use this for the rest of the turn or next turn. Place this card in the Lab Event Card Discard Pile.

Plasmid Rejection – The strain you are using rejects your plasmid. Lose the last Shape Card in your sequence. If you have no sequence, ignore this card and place it in the Lab Event Card Discard Pile.

Proper Lab Protocol – Your lab follows proper Lab Protocol. Pick one shape card from any Shape Card Pile. You may keep the card to add to your sequence or discard the card, placing it adjacent to the Shape Card Pile. Place this card in the Lab Event Card Discard Pile.

Random Mutation: Type I – While undergoing DNA manipulation, your DNA strand randomly mutates. Look at your last shape card to find out what shape it is. Assign numbers to the other shapes (For example, if you have a blue square, assign evens to triangle and odds to circle.)

Roll the die. Change the shape card to the new shape. You may then decide to keep or discard the new shape. Place this card in the Lab Event Card Discard Pile.

Random Mutation: Type II – While undergoing DNA manipulation, your DNA strand randomly mutates. Look at your last shape card to find out what color it is. Assign numbers to the other shapes (For example, if you have a green circle, assign 1and 2 to red, 3 and 4 to blue, 5 and 6 to orange.) Roll the die. Change the shape card to the new color. You may then decide to keep or discard the new shape. Place this card in the Lab Event Card Discard Pile.

Vacation – One of your lab technicians goes on vacation. Lose one person card for the rest of this turn and the next. Place this card in the Lab Event Card Discard Pile.

Visiting Lab Technician – Due to your lab's popularity, a lab technician wants to visit. Add 1 to your knowledge pool for the rest of this turn and the next. Place this card in the Lab Event Card Discard Pile.

Actions

The number of actions a player is allowed a turn is determined by the number of people in their lab, one action per person. *Note each Lab has a personal limit due to resources of the lab. A player cannot have more people over the personal limit.

Knowledge Pool

To obtain a new equipment, personal, paper or to win the game, a player must have their knowledge pool equal to that of the required number on the lower right hand of the card. To calculate a player's knowledge pool, first roll the 6-sided die. Add the number shown to the number of people in the lab. Then add the bonuses obtained from papers or lab techniques to that. *The equipment card Pipette can be used to modify this die roll.

To obtain equipment, papers, and meet the World Problem Criteria, a player must meet or surpass the number located in the bottom right of the card.

An example calculation of a player's total Knowledge Pool follows:

A player is trying to solve the world problem of Alternative Energies and needs to meet the requirement of 18 Knowledge Pool points. The player has 7 people in his/her lab, the French paper, the Deschaine paper, the Pipette equipment card,

Lab Personnel & Equipment Phase

In this phase, players can increase the size of their lab, obtain new equipment, and write scientific papers. The World Problem card will help to determine which of these options a player will choose, but all aid in helping players advance towards winning the game. To obtain these cards, players must meet the Knowledge Pool Requirement of the card and use an action. *A player can only obtain one paper, one person, and two equipment cards a turn.

World Problem Phase

A player may check to see if they meet the requirements of the World Problem Card. If they do not, the next player starts their turn. If they do, they may attempt to meet the Knowledge Pool Requirement by following the steps found under knowledge pool. *The equipment card Pipette can be used to modify this die roll. If the player ties or beats the Knowledge Pool Requirement, they win the game! The following are the 6 World Problem Cards found in this set.

Alternative Energies – Requirements:
- ·   Max Equipment Allowance
- ·   Max Lab Occupancy
- ·   Knowledge Pool of 18

HIV Pandemic – Requirements:
- ·   3 Papers
- ·   Max Equipment Allowance
- ·   Knowledge Pool of 18

World Hunger – Requirements:
- ·   3 Papers
- ·   Max Lab Occupancy
- ·   Knowledge Pool of 18

Environmental Clean-Up – Requirements:
- ·   2 Papers
- ·   2 Equipment
- ·   3 People
- ·   Knowledge Pool of 12

(Only requires the First 6 Shape Cards)

Malaria – Requirements:
- ·   2 Papers
- ·   5 People
- ·   Knowledge Pool of 12

(Only requires the First 6 Shape Cards)

Malnutrition – Requirements:
- ·   2 Equipment
- ·   5 People

·   Knowledge Pool of 12
(Only requires the First 6 Shape Cards)

Lab Techniques

All labs, except one, have a certain synthetic biology technique that will help them to solve the World Problem. Using a technique doesn't cost any actions, but they can only be used once a turn.

PCR Amplification – This technique lets you copy one brick you obtained during the Movement and Shape Card Selection Phase this turn and place it into the last spot in your sequence. You may still use your equipment to modify the shape card.

Restriction Digest – This technique allows you to insert one shape card you got this turn into any spot of your sequence. The sequence after the insertion will move and count for the next part of the sequence.

Site Specific Mutagenesis – This technique allows you to change the shape or color of one shape card obtained this turn. You may still use your equipment to further modify the shape card.

Homologous Recombination – This technique allows you to hold one shape card instead of discarding it. Once per turn, you may add the shape card to the end of your sequence. The shape card held may be exchanged with any shape card drawn, but this technique is not allowed to be used with any equipment or paper unless it was the same turn that the shape was held onto. *It is possible to place the shape card into your sequence and hold onto a new shape card on the same turn.

Equipment and Tech. Tree

There are 7 different equipment cards that players can use to advance their lab. There are 5 tiers of equipment, some having prerequisite devices that are needed. Consult the tech. tree found after the descriptions of each equipment item. For certain pieces of equipment, actions from people must be used. Multiple pieces of equipment can be used at once, but no piece of equipment can be used on a shape card obtained on a previous turn. Read the strategy portion of the rulebook to find ideas on how to optimize using your lab equipment.

Pipette – Once per turn, you may add or subtract 1 to any of your die rolls. This includes: movement roll, knowledge pool roles, and the roll during the World Problem Phase.

PCR Machine – Once per turn when drawing a shape card, you may instead look at the top 2 cards. Select 1 of the 2 cards to add to your sequence or discard. You may place the other one on the top or bottom of its respective shape card pile.

Autoclave – Once per turn when drawing a shape card, you may instead look at the top 3 cards. Select 1 of the 3 cards to add to your sequence or discard. Place the other 2 cards on the bottom of its respective shape card pile.

Media/plate – Once per turn, you may use one action to change the color of a shape card obtained this turn. This cannot be used on stored cards.

Gel Electrophoresis – Once per turn, you may use one action to change the shape of a shape card obtained this turn. This cannot be used on stored cards.

Centrifuge – Once per turn, you may use 2 actions to look at the top card of each shape pile. You may choose 1 shape card. Return all unselected cards to the bottom of their respected shape pile. * This card requires 3 people and 3 pieces of equipment in your lab to obtain.

Incubator – Once per turn, you may use 3 actions to pick your choice of any 1 shape card. You may then use 1 additional action to randomly draw 1 shape card. (Roll the 6-sided die. On a 1 or 2, draw a circle shape card; 3 or 4, draw a triangle shape card; 5 or 6, draw a square shape card.) *This card requires 5 people in your lab to obtain.

The following is the Equipment Tech Tree. In order to obtain further pieces of equipment, a player must have a required piece from the previous tier. * Tier 4 and 5 are the exception. A player must only have a piece of equipment from Tier 3 to buy Tier 4 or Tier 5.

Papers

Each paper has a unique benefit aimed to help your lab win. The number of papers a lab can have is based on the requirements of the World Problem. For example, the problem Environmental Cleanup has a requisite of 2 papers. This means that each lab can have 2 papers at a time. A player may swap out any paper for another paper, excluding the Anthony et al., and replace it with another recently obtained paper. The discarded paper goes back into play and other labs may obtain it.

Deschaine et al. – This paper adds 1 to your Knowledge Pool. *Use 3 copies in a 3-player game, 4 in a 4-player game.

Krug et al.– This paper adds 2 to your Knowledge Pool. *Use 2 copies in a 3-player, 3 in a 4-player game.

French et al. – This paper adds 3 to your Knowledge Pool. *Use 1 copy in a 3-player, 2 in a4-player game.

Nighswander et al. – This paper adds 4 to your Knowledge Pool. *Use 1 copy in a 4-player game.

Trumbauer et al. – This paper counts for 2 prerequisites of the World Problem. *For requisites that say full lab occupancy or personal limit, count this as 2 pieces of equipment or 2 people.

Schackmann et al. – This paper reduces the necessary number or actions to use the Incubator from 3 actions down to 2.

Anthony et al. – This paper allows you to skip requirement of the Tech. Tree for one equipment item. It also adds 1 to your Knowledge Pool. If you select this paper, you must have it for the entire game.

Shibberu et al. – This paper allows you to a card instead of discarding it during the Movement and Shape Card Selection Phase. You may hold up to 2 shape cards at a time. You may use 2 actions to combine the shape of one card with the color of the other and insert the newly formed card into the last spot of your sequence. Shape cards held on by this paper cannot be used with any other technique or paper, but the player may replace a shape card at any other shape card drawn this turn.

Goulet et al. – This paper reduces the necessary number of actions to use the Centrifuge from 2 actions down to 1.

Strategy
Here are some basic tips on strategy for the game:

· Keep in mind actions are determined by the number of people you have, but equipment is the best way to modify your sequence. Papers are very helpful for getting lab equipment. So, it is important to keep all 3 of these in balance. Your lab could be at max capacity, but if you do not have equipment for them to use, you will have an abundant amount of actions you cannot use.

· Remember the goals of the game: completing your DNA sequence, meeting the prerequisites on the World Problem, and meeting the Knowledge Pool of the World Problem. Do not focus too much on only 1 of the aspects to win the game.

· You can use multiple pieces of equipment in tandem. For example, a player just drew a shape card. He/she may use *Gel Electrophoresis* in combination with *Media & Plate* to transform it into the necessary piece that he/she needs, granted they have 2 actions to spend.

· There are a finite number of papers in the game, play accordingly.

· Do not forget that you can only obtain 1 person, 1 paper, and 2 pieces of equipment a turn. This does not mean you can only attempt to obtain them once a turn. The number of actions your lab has is the limiting factor. For example, a player has 3 people in his lab. He/she wants to obtain a pipette, meaning he/she needs to meet or beat a knowledge pool of 6. He/she uses 1 action to try to obtain it. He/she rolls a 2, putting his/her Knowledge Pool at 5, failing to obtain it. He/she may use another action to try to get it. He/she rolls a 4, putting his/her knowledge pool at 7, obtaining the *Pipette*. This means the player has one action left in this turn.

Special Rulings

Using Multiple Pieces of Equipment at Once – How many pieces of equipment a player can is limited by the number of actions they have and the cost benefit of combining them.

· **Example** – A player has the *Gel Electrophoresis* and *Media & Plate* and 3 people in their lab. He/she requires a Blue Triangle as the next shape in their sequence. They drew a Red Square during their Movement and Shape Card Selection Phase. They may then use 2 of their

3 actions, 1 to use *Gel Electrophoresis* and 1 to use *Media & Plate*, to change the shape from Square to Triangle and the color from Red to Blue. Look at the Triangle Shape Discard pile for a Blue Triangle Card to replace the Red Square. If there is not one, use the Shape and Color Changing Tokens to mark on the shape and color on the Lab Player Mat.

Multiple Shape Cards in One turn – There are currently only 5 ways to get multiple shape cards in one turn. The rulings on each follow:

·   **Centrifuge –** This equipment allows you to spend 2 actions to look at the top card of each shape pile. You may choose 1 shape card. Return all unselected cards to the bottom of their respected shape pile. A player may use this injunction with another piece of equipment such as the *Autoclave*. For example, a player spends 3 actions to use the *Centrifuge* to look at the top card of each pile. He/she may then use the *Autoclave* to select one of the three piles; in this case he/she selects the triangle shape card to draw three from. The player would then look at the top square, top circle, and top three triangle cards. He/she would then select 1 of the 5 cards and put the rest on the bottom of their respective shape pile. The player may then use additional equipment such as *Media & Plate* and/or *Gel Electrophoresis* to modify the shape or color of the shape card.

·   **Homologous Recombination** – This lab technique allows a player to hold one shape card instead of discarding it. This card cannot be used in juncture with the *Shibgberu Paper* when combining shapes, but they both can be use independently of each other. You may swap a shape card at any time but you can only have one shape card held at any point in time. You may change the shape card before you store it, but once it is stored, no further modifications can be made.

·   **Incubator –** This equipment allows you to use 3 actions to pick your choice of any 1 shape card. You may then use 1 additional action to randomly draw 1 shape card. (Roll the 6-sided die. On a 1 or 2, draw a circle shape card; 3 or 4, draw a triangle shape card; 5 or 6, draw a square shape card.) A player may use this injunction with another piece of equipment such as the *PCR Machine*. For example, a player needs a blue triangle followed by a red triangle and spends 3 actions to use the Incubator. He/she then uses the *PCR Machine* to look at top 2 cards of the triangle shape pile, selects a blue triangle and puts a red triangle of the triangle shape pile. He/she then spends and extra action to roll the die and got a 2. He/she then uses the *Pipette* equipment card to increase the number to 3, so the player would draw the red triangle card he/she put there.

·   **PCR Amplification** – This lab technique allows a player to copy the original unmodified shape card they drew on their *Movement and Shape Selection Phase* portion of their turn. The first card may be placed into the player's sequence or discarded. You may modify both shape cards. For example, a player needs a red triangle followed by a blue triangle to complete their sequence. He/she drew a red triangle. The player may place that shape card into the sequence and then activate the *PCR Amplification* to copy the card. He/she may then use *Media & Plate* to change the color of the shape to blue to complete their sequence.

·   **Shibberu et al. Paper** - This paper allows you to a card instead of discarding it during the Movement and Shape Card Selection Phase. You may hold up to 2 shape cards at a time. You may use 2 actions to combine the shape of one card with the color of the other and insert the newly formed card into the last spot of your sequence. Shape cards held on by this paper

cannot be used with any other technique or paper, but the player may replace a shape card at any other shape card drawn this turn. Equipment may be used to modify the shape before it is placed on the paper, but the shape must have been drawn during the Movement and Shape Card Selection Phase.

6. Index

7. Glossary

- Actions - In Biopioneer, the number of activities a user may undertake on a given turn.
- Apple App Store: The Apple App Store is a digital application distribution platform for iOS developed and maintained by Apple Inc. The service allows users to browse and download applications from the iTunes Store that were developed with the iOS SDK published through Apple Inc.
- Equipment - In Biopioneer, items which allow the players to use special abilities during the game.

- IGEM - The International Genetically Engineered Machine (IGEM) competition is a worldwide Synthetic Biology competition aimed at undergraduate university students.
- iOS - A mobile operating system developed and distributed by Apple Inc. Originally released in 2007 for the iPhone and iPod Touch, it has been extended to support other Apple devices such as the iPad and Apple TV.
- iOS Human Interface Guidelines: describes the guidelines and principles that help you design a superlative user interface and user experience for your iOS app.
- Knowledge Pool - In Biopioneer, represents a player's lab technology level. Used to determine success or failure when performing actions.
- Papers - In Biopioneer, game items which allow the players bonuses to their knowledge pool.
- People - In Biopioneer, a collectable that determines the number of actions per turn.
- World Problem - The goal of the biopioneer board game is to solve a world problem by acquiring required materials and completing the DNA sequence.
- Youtube.com - A popular video sharing website.