

Animation in Cell Biology

Final Report



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CSCE 606: Software Engineering

Instructor: Dr. Hank Walker

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Team Roles

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Relevant Links

Pivotal Tracker	https://www.pivotaltracker.com/n/projects/2467349
GitHub	https://github.com/dsandeep97/BiologyAnimation
Poster and Demo presentation	https://www.youtube.com/watch?v=tCelAEoYs2w
Deployments	Slide8 , Slide16 , Slide38 , Slide46 , Slide53 , Crossword , This or That , Tile Matching , 8-puzzle , This or That (Cell Structures) , This or That (Cell Structures) , This or That (Stress) , Map the Response
Wiki	https://github.com/dsandeep97/BiologyAnimation/wiki

Implementation Summary

The customer for this project is the Veterinary Medical & Biomedical Sciences department of Texas A&M University. The main customer need is to develop and integrate interactive animations into the Stepstone learning environment to improve the biology learning experience of middle school students. Our team mainly focused on the Cell Biology module, and have added some of the animations in the Stress Module as well.

We have implemented animations using HML5, CSS, JavaScript and JQuery. We have divided the project goal into two parts. First is to improve the legacy animations. Second is to design new animations. We are a team of 6 members, and we have usually assigned 2 people for each user story. In the initial phase, we have tried cucumber-js and selenium for testing, but since the focus of the project is to build new animations, we didn't spend much time figuring out the testing framework. Instead, we focused on manual testing of all our animations. For each iteration, we made sure we had progress on our user stories. Once we had the animations ready, we verified the animations on multiple mobile devices, Ipad and on multiple browsers, and finally on the StepStone test environment. Further, we have parameterized some of our animations so that these can be reused at multiple places. We have finally deployed them to StepStone in the final iteration i.e., Iteration 4. We were able to deploy most of our animations on the StepStone production environment with the help of StepStone developer Daniel Shuta.

User Stories

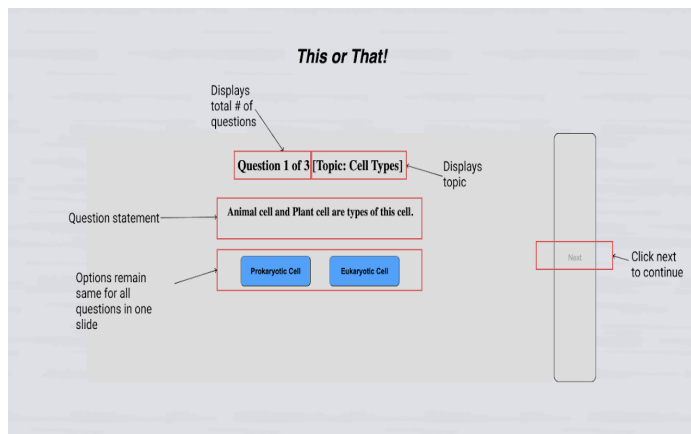
1. **Feature:** Develop a “This or That” animation
Module: Cell biology
Points: 3
Status: Completed (Deployed)

As an Instructor

So that the students understand the difference between two topics

I want to ask if a given statement refers to one topic or another

For “This or That”, the screen displays a statement that can refer to one of the two options given as buttons. User has to select which of the two options the statement refers to. The image shows the layout of the animation. For each slide, we display the topic of the questions and the number of questions. The options remain the same for all questions in one slide. The idea is to reiterate the differences between the two options over multiple questions.



Functionality: Clicking the correct answer displays “That’s right” and the user has to click on “next” to go to the next question. Clicking the wrong answer displays a hint and the user has to click on “next” to get to the next answer. The rationale is that since there are just two options, even after choosing the wrong answer, the user will know what the right

answer was. That is why there is no option to redo the question on getting it wrong.



2. **Feature:** Develop a crossword puzzle game

Module: Stress

Points: 3

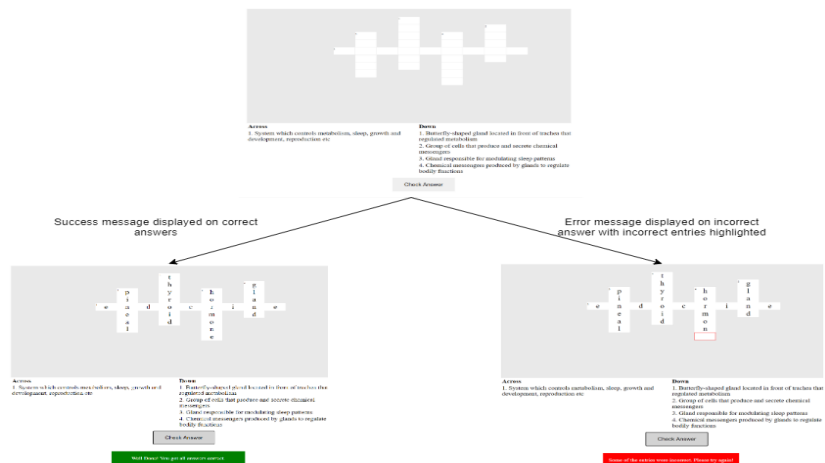
Status: Completed (Deployed)

As an instructor

So that the students can reinforce the concepts in the topic

I want to create a crossword puzzle for the students to solve

Crossword is a word puzzle game, consisting of a grid of squares. The goal of the game is to fill the grid with letters, forming words by solving a set of clues. The crossword puzzle was created using clues from the endocrine system of the stress module. Once the students have filled in the letters with the help of the clues, they can click on the “**Check Answer**” button to check their answers. In case the words are correctly entered, a success message is displayed indicating that the puzzle is correctly completed. In case of errors, an error message is displayed, and the wrongly filled squares are cleared out and highlighted in red, allowing the students to attempt these and check their answers again.



3. **Feature:** Develop a 8-puzzle picture game

Module: Cell Biology

Points: 3

Status: Completed (Deployed)

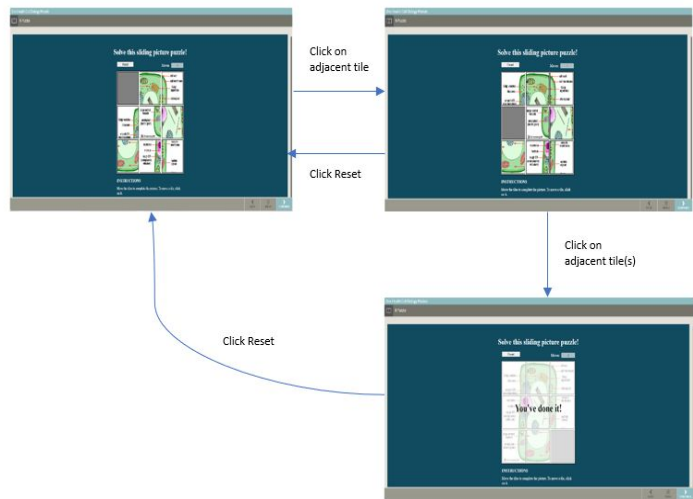
As an Instructor

So that the students can learn the configurations of different components of a cell

I want to create an image with an 8-puzzle

8-puzzle is a board quiz with 9 fields. 8 of them represent pieces of an image taken from any material explained in the module. The last field remains empty. The goal is to arrange the pieces in such a way that it forms a complete picture. For completing this

quiz we are allowed to move only pieces which are adjacent to the empty piece. One can click on any box adjacent to the empty one and it will move to the empty box and leave itself empty. After starting, we can click on any box adjacent to this and the box will move the empty space. While solving the quiz, if you reach a point where you have put all the pieces together the quiz will stop and display a prompt regarding the same as the following. When reset is clicked, the game/quiz goes back to its initial configuration and the number of moves are reset.



4. **Feature:** Develop a tile matching game

Module: Cell Biology

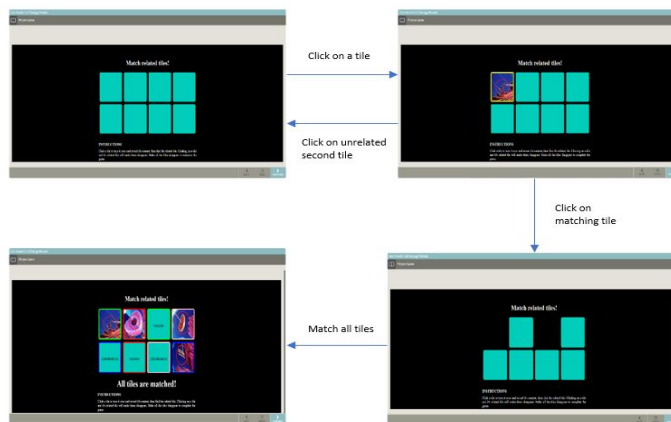
Points: 3

Status: Completed (Deployed)

As a Student

So that I can learn which two entities are related to each other

I want to match the tiles that are related



This quiz is about matching the tiles. The initial configuration has a 4x2 board with 4 pairs of related tiles. The goal is to match and remove all the tiles.

Initially, the contents of the tiles are hidden and the content is revealed on clicking the tile. When the two tiles selected are not related, then the tiles go back to normal, but when the two tiles selected

are related to each other, then the tiles disappear. Finally, when all the tiles are matched,

it displays a message “All tiles are matched” and we show the correct matches with 4 different colors.

5. **Feature:** Develop a “drag and drop definitions” animation

Module: Cell Biology

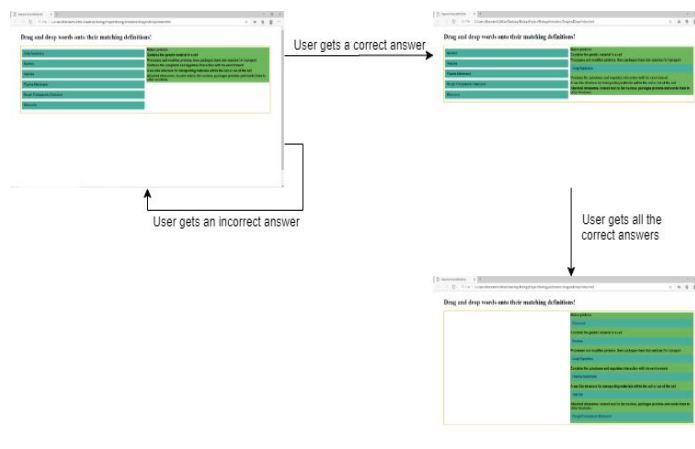
Points: 3

Status: Completed (Not Deployed)

As a Student

So that I can definitions of several terms in cell biology

I want to drag and drop definitions to the corresponding terms



In this module, we present the user with a column of vocabulary words and a column of definitions. The user can drag and drop vocabulary words onto the definitions. If the pairing is correct, the word appends under the definition. If the pairing is incorrect, the word returns to the first column.

6. **Feature:** Deploy the animations on StepStone learning system

Points: 3

Status: Completed

As a developer

So that the students can access the animations in StepStone learning environment

I want to deploy the animations on StepStone system

Since we do not have access to the production server ourselves, In this user story we deployed our working apps to the production environment with the help of Danial Shuta. For deploying a mini-app (such as 8-puzzle) into a production environment we need to provide the following information to Daniel:

- **Module ID:** SEPACellBio [This is related to the module that you were working on such as Cell Biology (SEPACellBio) or Stress Module (SEPASTressModule).]

- **Path ID:** “practice” [This is the sub-module information. More info on how to get Path ID is covered in the Tutorials section in the document.]
- **Step ID:** 45 [More info on how to get Step ID is covered in the Tutorials section in the document.]

7. **Feature:** Develop “Venn Diagram” animation

Module: Cell biology Module

Points: 3

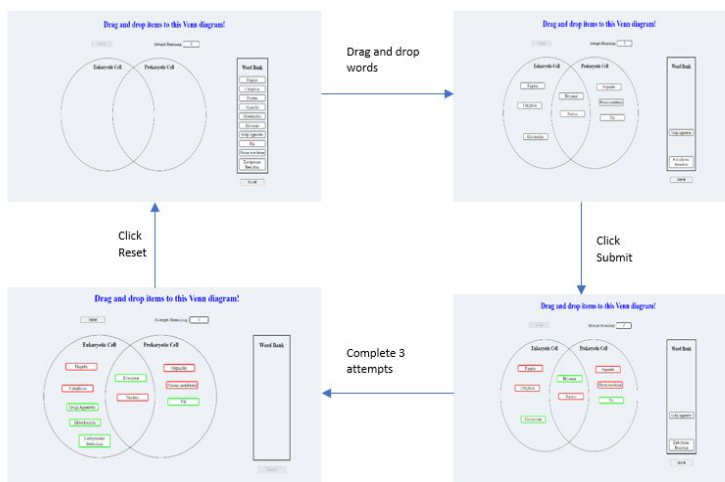
Status: Completed (Not Deployed)

As an Instructor

*So that the students understand the distinct and also the common characteristics
I want to develop a Venn diagram animation*

This quiz is about dragging and dropping the words from the word bank into the appropriate location. Since this is a venn diagram, the words that are appropriate for both of the circles should be dropped in the common region. Three attempts were provided initially, and each time the student clicks on the submit button, it is

counted as an attempt. Below is a snapshot of the UI when the words are dragged and then submit is clicked. The ones that are in green are in the appropriate location, whereas the ones in red are placed inaccurately and can be dragged and dropped into other locations. Once all 3 attempts are done, “Reset” option is enabled, and all the words go back to the word bank. This also resets the number of attempts to 3 again.



8. **Feature:** Parameterize “This or That” animation

Module: Cell biology/Stress Module

Points: 3

Status: Completed

As a developer

So that the animation template can be used for multiple slides

I want to parameterize This or That animation

In this story, we have condensed all the functional code in a html (index.html) and a js (thisorthat.js) file that remain the same for any slide of "This or That". The changes occur in another js file (contents.js). Depending on the topic, the questions, answers and the hints will change. The contents.js file has a key-value structure in which one can add, change or delete the questions. Each "This or That " animation will hence have 3 files : index.html, thisorthat.js and a modifiable contents.js. More detailed information will be provided under section "Parameterized Animations".

9. **Feature:** Make animations mobile-compatible

Points: 3

Status: Completed

As an Instructor

So that students can access the material on mobile

I want to make the animations and games mobile-compatible

To make the animations compatible with mobile devices, viewport meta tag is used which instructs the browser to use the actual device width with a scaling factor of 1. Then, we have used media queries to deliver different css styles to different mobile screen sizes. Most of the time, relative widths are used to avoid issues on resizing or different screen sizes.

10. **Feature:** Make animations on StepStone compatible

Points: 2

Status: Completed

Mini apps are placed inside the StepStone environment in a customized "iframe" element. Therefore, the apps had to be resized using an iframe resizer . If this isn't triggered properly, the app is incompatible with StepStone. Also, using relative widths for the html page didn't work well with StepStone. Therefore, the height of the html, body and/or the main container is changed to use a fixed value (600px or 800px for example.)

Legacy project (Refactored User Stories)

There were 12 slide folders in the legacy project. Every slide contained its own HTML and JS file. We went through these animations in the legacy project and came up with these below user stories to improve the animations and also make the legacy code reusable at multiple places with very less modifications and effort.

1. **Feature:** Rearrange images in the correct order in “Map the Response” slide

Module: Stress (Slide 26)

Points: 2

Status: Completed (Deployed)

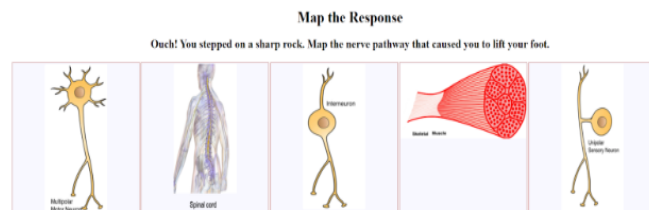
As a Student

So that I can test my knowledge of the order of the nerve pathway

I want to map the steps in nerve pathway in a correct order

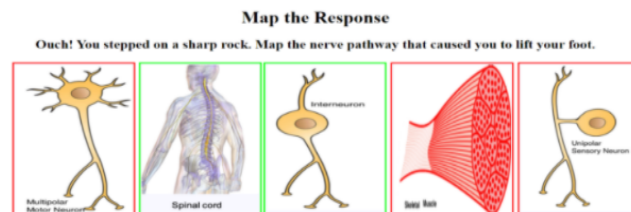
This slide displayed a set of images corresponding to the steps in the nerve pathway's response to a stimulus. There were a few issues observed with the implementation -

- The message “Incorrect ordering!” shows up by default when the slide is opened without the student attempting to reorder images.
- The slide also displayed overlapping and duplicated tiles when the windows are resized



Incorrect Ordering!

↓
Added verify button and highlighted
correct/incorrect entries



Verify!
Incorrect Ordering!

The first issue was resolved by removing the initial message and adding a button to check the answer which the student can click after he has reordered the images. For the tile duplication,

we removed the cloning of image tiles which was causing the issue, instead using the initial set of tiles while moving images around. Further, while displaying the answer, additional feedback is provided to the student by highlighting the images that are correctly ordered and those that are incorrect.

2. **Feature:** Modify Label Boxes to have uniform size

Module: Cell Biology (Slides 8, 38, 46 and 53)

Points: 2

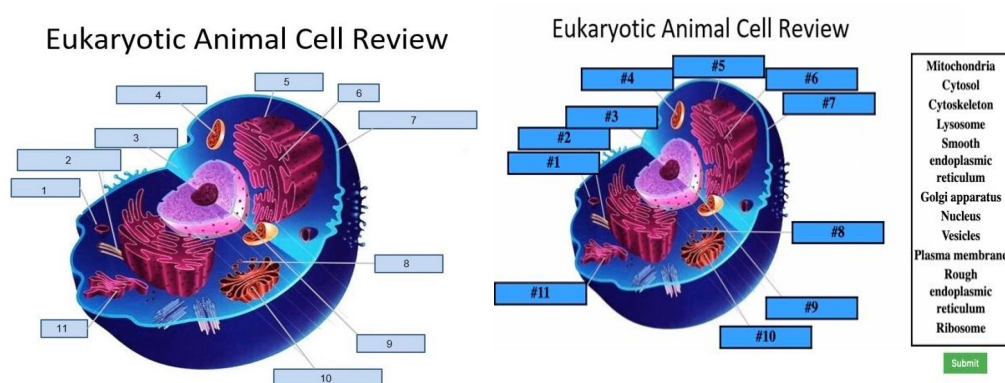
Status: Completed

As a Student

So that I can intuitively label the diagrams instead of relying on the size of the boxes

I want to have the label boxes to be of uniform size

There are multiple slides in which the user is expected to fill in the labels in the boxes appropriately for a figure. In such cases, varying sizes of the label boxes implicitly hint the users on what is the right answer that should be entered in that box. Such implicit hints can be misleading and hence we have fixed these slides to ensure that the boxes to be filled in have uniform sizes. Below are some examples of the slides that have been fixed. The images on the left hand side are before our code fixes and the ones on the right hand side are after the proposed changes.



3. **Feature:** Improve color accessibility for color-blind people

Module: Cell Biology

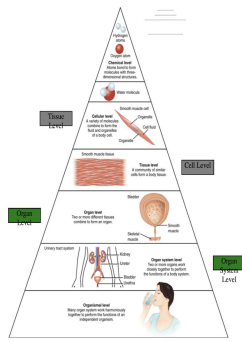
Points: 1

Status: Completed

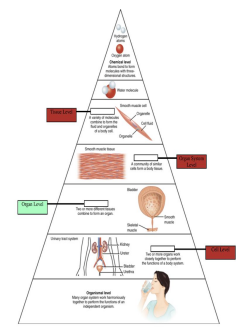
As a color-blind student

So that I can have a good understanding of the UI

I want to be able to differentiate between the colors on screen



Differentiating between certain colors is difficult for users with color-blindness. To address this issue, we chose a color palette that contains color-blind accessible alternatives for the usual green, red, orange, yellow and blue. This color palette has been used wherever differentiating between colors is required. Figure on the right shows the updated colors.



Parameterized animations

1. This or That

As mentioned earlier, each animation of “This or That” has three files : index.html, thisorthat.js and contents.js. Among these, index.html contains the css and html code for what is displayed on the page. thisorthat.js and contents.js work together. thisorthat.js takes the data from contents.js and decides what content is displayed when.

```
1 var questions = [
2 {
3   "question" : "It often has appendages.",
4   "options" : ["Prokaryotic Cell", "Eukaryotic Cell"],
5   "answer" : "Prokaryotic Cell",
6   "hint" : "That's Incorrect! Revisit Cell Types!",
7   "topic" : "Cell Types"
8 },
9 {
10  "question" : "Animal cell and Plant cell are types of this cell.",
11  "options" : ["Prokaryotic Cell", "Eukaryotic Cell"],
12  "answer" : "Eukaryotic Cell",
13  "hint" : "That's Incorrect! Revisit Cell Types!",
14  "topic" : "Cell Types"
15 },
16 {
17  "question" : "It has no membrane-bound organelles.",
18  "options" : ["Prokaryotic Cell", "Eukaryotic Cell"],
19  "answer" : "Prokaryotic Cell",
20  "hint" : "That's Incorrect! Revisit Cell Types!",
21  "topic" : "Cell Types"
22 }
23 ];
24
25
26
```

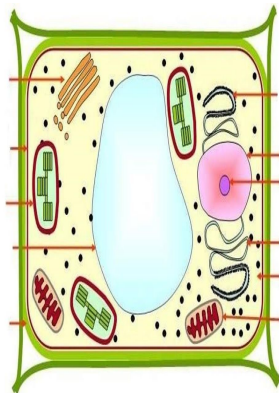
The developer need not change anything in the files except for contents.js. Here is a screenshot of the data in contents.js. Each entry in the data structure contains: question, answer options, correct answer, hint for the wrong answer, and the topic of the question. The developer would need to add these fields for each question in this file.

2. Drag and Drop animations

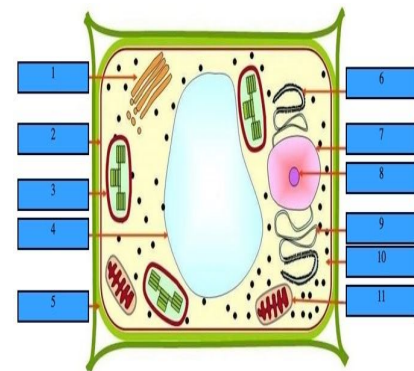
The new drag and drop code flow is simple enough to be quickly replicated to other places where this needs to be done. A drag and drop mini app can be inserted wherever we have some components in a picture, and we want users to name those components

such an example is given in Legacy animations section 2. First step in this to have a picture with empty labels as in figure a) below. After this you can clone the code from any drag and drop mini app such as slide 46 and place your image in the image folder. Webpage of this app has two containers : question and answer. Question container has labels with all the question boxes with their ids and the answer container has corresponding answers and ids. The change required would be in the placement of bounding boxes and that each developer has to do according to his input image. You need some trial and error to find out where your boxes need to be according to arrows given in the image and make it look like below figure b). Once you do that, no other code change is required additional to changing questions and answers for your input image and this animation would be deployment ready. So the only code change needed is in the “index.js” for adjusting the bounding boxes and adding your questions and answers.

For deploying this on mobile, you do not need to take care of anything extra as our template already handles all those mobile related issues.



a)



b)

3. Tile matching

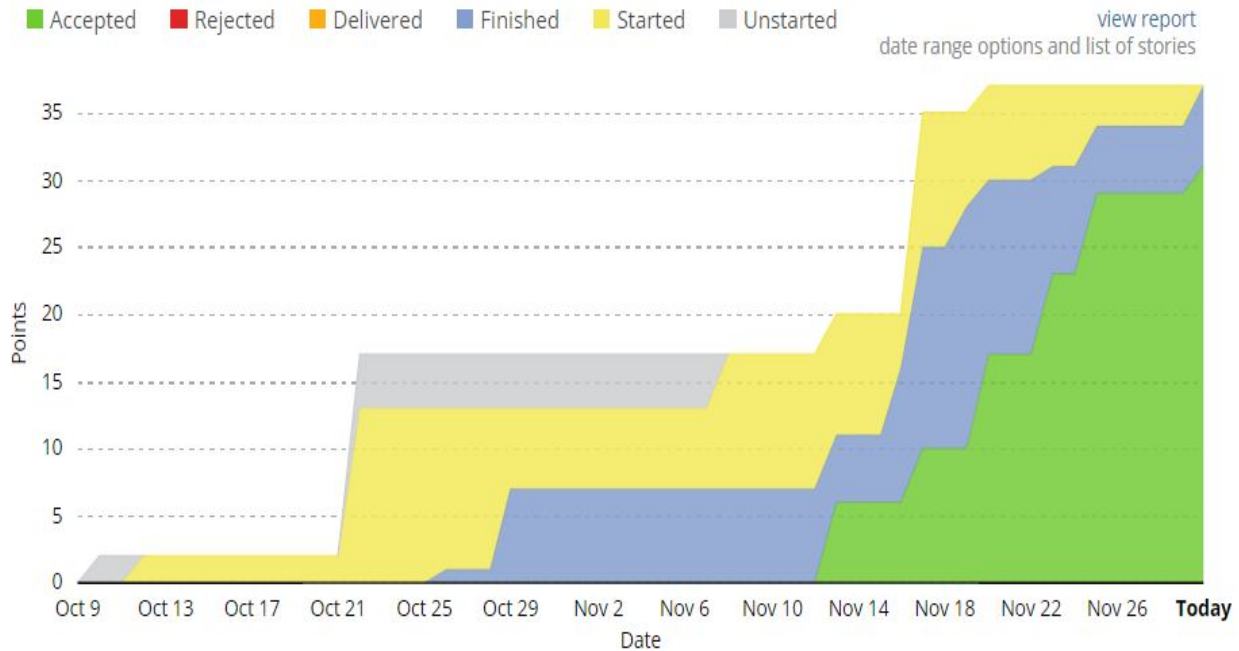
To use this animation, modify tileContents.js to include the list of words. One can add any number of words in this list. When the html page loads, it randomly picks 4 of these words and generates the tiles for the game. Next step is to have the corresponding images placed in the folder “img”, with the exact same name as the word in the list, and extension as jpg.

```
var tiles = [
  "cytoskeleton",
  "golgi apparatus",
  "lysosome",
  "mitochondria",
  "nucleus",
  "ribosome",
  "vesicles"
];
```

```
$ ls -la practice/tilematching/img/
total 308
drwxr-xr-x 1 dsand 197609  0 Nov 24 19:32 ./
drwxr-xr-x 1 dsand 197609  0 Nov 27 15:05 ../
-rw-r--r-- 1 dsand 197609 37915 Nov 24 19:32 cytoskeleton.jpg
-rw-r--r-- 1 dsand 197609 49684 Nov 24 19:32 'golgi apparatus.jpg'
-rw-r--r-- 1 dsand 197609 37752 Nov 24 19:32 lysosome.jpg
-rw-r--r-- 1 dsand 197609 42516 Nov 24 19:32 mitochondria.jpg
-rw-r--r-- 1 dsand 197609 44403 Nov 24 19:32 nucleus.jpg
-rw-r--r-- 1 dsand 197609 43814 Nov 24 19:32 ribosome.jpg
-rw-r--r-- 1 dsand 197609 40002 Nov 24 19:32 vesicles.jpg
```

Iteration summaries

Velocity graph



1. Iteration 0

Points completed: 0

We spent this iteration understanding the legacy team code changes. We have contacted Unnati Eramangalath, Scrum Master for the legacy project (Fall 2019) and have also contacted Siddharth Sundar, Team member for the legacy project (Spring 2020) to understand the legacy project and the requirements. We have then come up with user stories and an action plan to improve the legacy slides and also the user stories to bring in new animations to the Cell Biology and Stress module.

2. Iteration 1

Points completed: 0

This iteration, we focused on understanding how the application developed can be deployed to the StepStone environment and how can the applications be tested on the test environment provided. We have picked some of the user stories for this iteration (These are the modifications to the legacy slide) and have completed implementing these for this iteration.

3. Iteration 2

Points completed: 0

For this iteration, we have coordinated with other teams working on the biology animations project (Stress Module) and moved our changes for the user stories implemented in the previous iteration to an appropriate GitHub repository. Then, we have picked 6 of our user stories to implement this iteration. These involve developing 8-puzzle, This or That animation, Tile matching memory game, crossword puzzle, drag and drop definitions animations. We have completed developing these animations in this iteration.

4. Iteration 3

Points completed: 0

Firstly, we have spent this iteration getting the user feedback on the animations we have developed and improved the animations based on the user studies. Next, we have verified the animations developed on multiple mobile devices, multiple browsers, Ipad, and finally StepStone test server. We have also parameterized tile matching animation in this iteration.

5. Iteration 4

Points completed: 23

We have parameterized “This or That” animation during this iteration with an aim to reuse the animation at multiple places. We have improved the drag and drop legacy slides, and finally we have implemented venn diagram animation in this iteration. The major focus however this iteration was to get the animations deployed in the production server. We were able to deploy with the help of developer Daniel Shuta the following animations in this iteration: 8-puzzle, tile matching, crossword, drag and drop legacy slides and This or That.

6. Post Iteration 4

Points completed: 8

We have deployed the Map the response slide in the Stress module, and have added This or That animation in multiple modules in this period after iteration 4.

Customer Meeting Summaries

Iteration	Meeting Time	Customer Meeting Summary
Iteration 0	25th Sept, 2020 12 PM - 1PM	Prof. Walker (Point of contact for this project) shared an overview of the project, goals for the project, some suggestions on the user stories.

		<p>Meeting minutes: https://docs.google.com/document/d/1YK_A-KaejPg_SgJ7rqEReQgpjS9vMQhdgACfsZt_fnY/edit?usp=sharing</p>
Iteration 1	1st Oct, 2020 5 PM - 6PM	<p>We went through our user stories we have come up with during Iteration 0. Prof. Walker suggested removing some of the user stories (which are based on look/feel of the website and other stepstone functionality related). He also suggested we start working on the user stories and also think of adding some of the games.</p> <p>Meeting minutes: https://docs.google.com/document/d/1AjEa2zGGbR4eeyTUdUpUw9-NjTgtqeuR3JLaP3-_g7Q/edit?usp=sharing</p>
Iteration 2	15th Oct, 2020 5 PM - 5:30 PM	<p>We have demoed the legacy modifications we have made as part of the Iteration 1, and received some feedback on improving these animations. Prof. Walker suggested parameterizing the animations so that these can be reused at multiple places.</p> <p>Meeting minutes: https://docs.google.com/document/d/1uQ1JsF5LxztU_GSNjR6eMTN0cnn2JavNkKIJGm4OPs8/edit?usp=sharing</p>
Iteration 3	29th Oct, 2020 5 PM - 5:30 PM	<p>We have demoed the animations that we have developed in the previous iteration and received some feedback on the animations. It was emphasized that the focus can be put on developing the animations and continue with the manual testing of the developed applications.</p> <p>Meeting minutes: https://docs.google.com/document/d/1xbCWzUvYNenVNwo5LaV3_umn6hI4rvQkFG-b8kAddlk/edit?usp=sharing</p>
Iteration 4	12th Nov, 2020 5 PM - 5:30 PM	<p>We got info regarding the demo of our animations with people from Vetmed, and got some of the other questions clarified in this meeting.</p> <p>Meeting minutes: https://drive.google.com/drive/folders/15crCEPX-2U_FDxbE5v0MUCPaahRfH73n?usp=sharing</p>

BDD/TDD Process

Since the project was a little unconventional compared to the usual software engineering project with a database and usable RSpec/Cucumber tests, we focused on manual testing to ensure our applications are working properly.

1. All of the team members created apps locally and ensured they work on browser, mobile and Ipad.
2. We integrated the applications into the Stepstone environment
3. We did a code review where each team member was asked to review another team member's application and provide feedback
4. We have also let users outside the team to try out the animations and suggest feedback.

Cucumber-js tests:

We have used Cucumber.js to write automated test cases for the “map the response” slide in the Stress Module. Cucumber.js is a test framework in Node.js for behavior-driven javascript development. This is then integrated with Selenium-webdriver. Selenium acts as a browser simulator.

Manual Testing:

To test the apps on browser and mobile phones, we can just open the html files in the source code from the browser. We have manually validated the formatting of the newly added content and modified legacy content on multiple browsers such as Chrome, Firefox and Safari. We have also tested the same on Android and iOS based mobile devices.

Mobile/Ipad testing from browser:

To test the apps on Mobile and Ipad screens, we used the “inspect element” option on chrome. Chrome gives the option of choosing the screens of a number of devices including android devices such as Moto G4, Pixel 2, etc as well as iPhone models, Ipad and Ipad pro. We can also see how the animation would work in different orientations of these screens. Using this method, we verified the functionality of our apps on mobile devices.

Testing on StepStone server:

For testing our applications, we deployed our applications to the stepstone testing environment and then launched the stepstone test server to verify the layout and functionality of the applications. We followed the steps outlined by one of the previous teams to deploy our code to the testing server. This involved copying our application folder on to the test server and then modifying the configuration file to point to our folder, after which the application can be accessed in the stepstone environment by going to the following [url](#). The detailed steps for testing can be found in the tutorials of the previous team's report [here](#).

Configuration Management:

GitHub:

We have used GitHub as a configuration management tool for the project. The changes are not merged directly on to the master branch. Instead, every team member created a new branch to upload their changes. Then he/she raised a pull request, which is reviewed by other team members before merging the change into the master branch. After every iteration, we have created a release tag. In total, we had **10 branches**, and we have made **4 releases** (one after each iteration)

Issues:

1. Pivotal tracker

Pivotal Tracker is a project planning tool that helps software developers determine how long a feature will take depending on the team's current performance. It assigns different states to the task being tracked and a developer can update the state once he has made progress on it. One key issue with our project was deployment state. We were able to finish many user stories in our earlier iterations but those stories couldn't get deployed early due to misunderstanding. Moreover, the way the deployment is set up for our project, it makes us dependent on someone outside the team as well to deploy things on production. Owing to these issues, our deployment of user stories happened in 4th iterations and this made all our tasks pending. This is the reason why we have no points in our initial 3 iterations and 23 in the 4th (last) iteration and the plot of the velocity looks skewed at the end.

2. Mobile compatibility

Touch (i.e., drag and drop) code doesn't work for mobile devices. To make this work, we have included touch-punch.js jquery module. To make the animations compatible with mobile devices, viewport meta tag is used which instructs the browser to use the actual device width with a scaling factor of 1. Then, we have used media queries to deliver different css styles to different mobile screen sizes. Most of the time, relative widths are used to avoid issues on resizing or different screen sizes.

3. Stepstone issues

Mini apps are placed inside the StepStone environment in a customized "iframe" element. Therefore, the apps had to be resized using an iframe resizer. If this isn't triggered properly, the app is incompatible with StepStone. Also, using relative widths for the html page didn't work well with StepStone. Therefore, the height of the html,

body and/or the main container is changed to use a fixed value (600px or 800px for example.)

4. Deployment issues

There is no way for us to upload our apps into the production environment. StepStone developer Daniel Shuta would do this. We ensured that we tested the apps on a test framework simulating StepStone, but still we faced some height related issues on the production server due to differences in the way iframe resizer interacts with the mini-app. Also creating a new version of the module, with new instances of some paths does not include the steps already added and Daniel Shuta had to manually create these again to retain apps, nor existing mini apps.

Tutorials

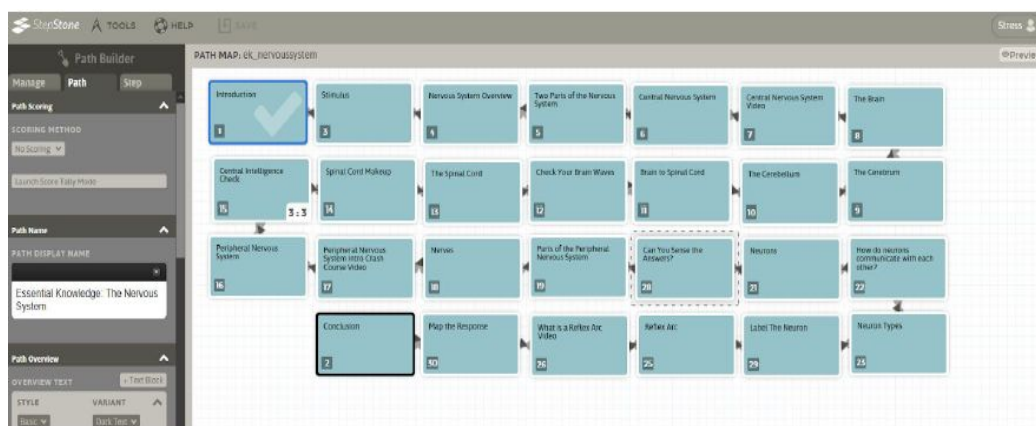
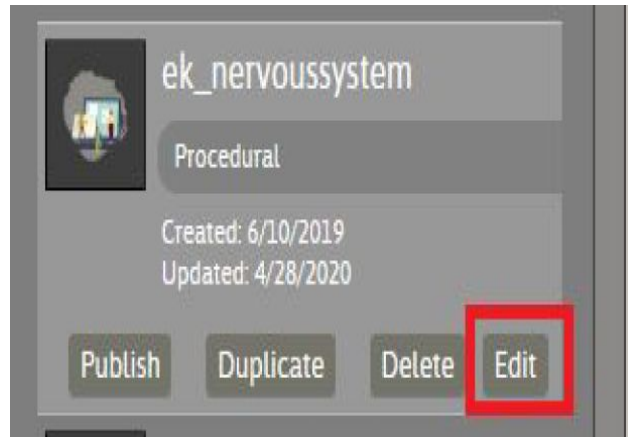
Identifying Step ID of the Slide

1. Go to the StepStone learning path editing website: <https://stepstonelearning.net/>
2. Log in with whatever credentials match your project. The account portal for all modules is **TAMU-NIH-1**

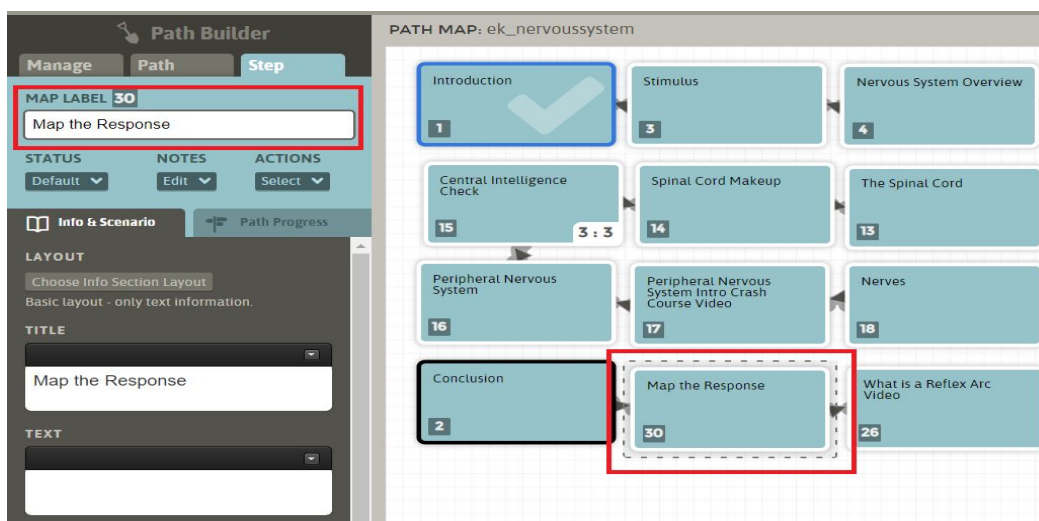
Module Name	Username	Password
Cell Biology	Cells	PEER1
Stress	Stress	PEER2
Ecology	Ecology	PEER3
Clinical Trials	ClinicalTrials	PEER4
Infectious Diseases	InfectiousDiseases	PEER5



3. Then choose a path and click 'Edit', you will be shown all of the internal steps that this path contains.



- Then clicking on the slide will give you all the relevant information. Here you can know the Step ID. In the image below, we can see that the Step ID for “map the response” slide is 30.



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