

Biochemistry Virtual Lab Industry Review Panel

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Client: Professor Stone [BBMB]



Client Requirements

- ◇ Program that allows students to complete BBMB 102 lab modules virtually
 - ◇ Offers similar experience to physical lab
 - ◇ 3D environment for completing lab modules
- ◇ Must be easily accessible to all students
 - ◇ Website or simple installation
 - ◇ Minimum specifications are met by most student laptops
- ◇ 7 Lab Modules
 - ◇ Each module corresponds to a different introductory lab course
 - ◇ Lab progress is recorded in Canvas

Definition

Lab Module: An implementation of an entire lab procedure in the virtual lab program. Each lab module corresponds to a physical lab assignment in BBMB 102.

Initial Requirement Refining

- ◇ Web based app hosted from an ISU provided virtual machine
 - ◇ Satisfies client's accessibility requirements for students
 - ◇ Requires auxiliary use of VPN to connect to ISU servers
- ◇ Focus on Lab Environment development
 - ◇ Add usability features at Client's request, such as alternative camera controls
 - ◇ Create comprehensive environment for future development teams to produce lab modules
- ◇ Reduce scope from developing multiple modules to only Module 3
- ◇ Remove Canvas integration from scope to devote more resources to other parts of project



Continuous Requirement Refining

- ◆ Client communication
 - ◆ Detailed module "scripts"
 - ◆ List and photos of necessary lab objects
 - ◆ Client feedback after each iteration
- ◆ In person laboratory demo of Module 3



Dr. Stone demonstrates the lab procedure in Module 3



Assumptions & Limitations

Assumptions

- ◆ The product will be primarily used by Iowa State University students
- ◆ The users will have a stable internet connection and reliable computer
- ◆ The product will not be used on mobile devices

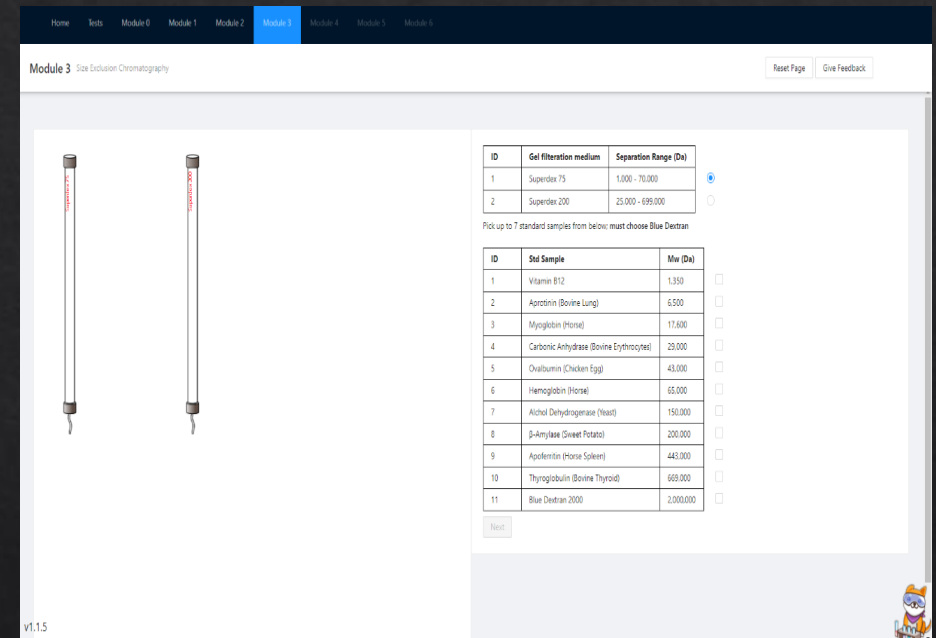
Limitations

- ◆ The lab procedure must be possible to complete with mouse (or trackpad) & keyboard
- ◆ The load time for the site will be less than 5 seconds
- ◆ Computers may have as little as 4GB of RAM



Previous Work

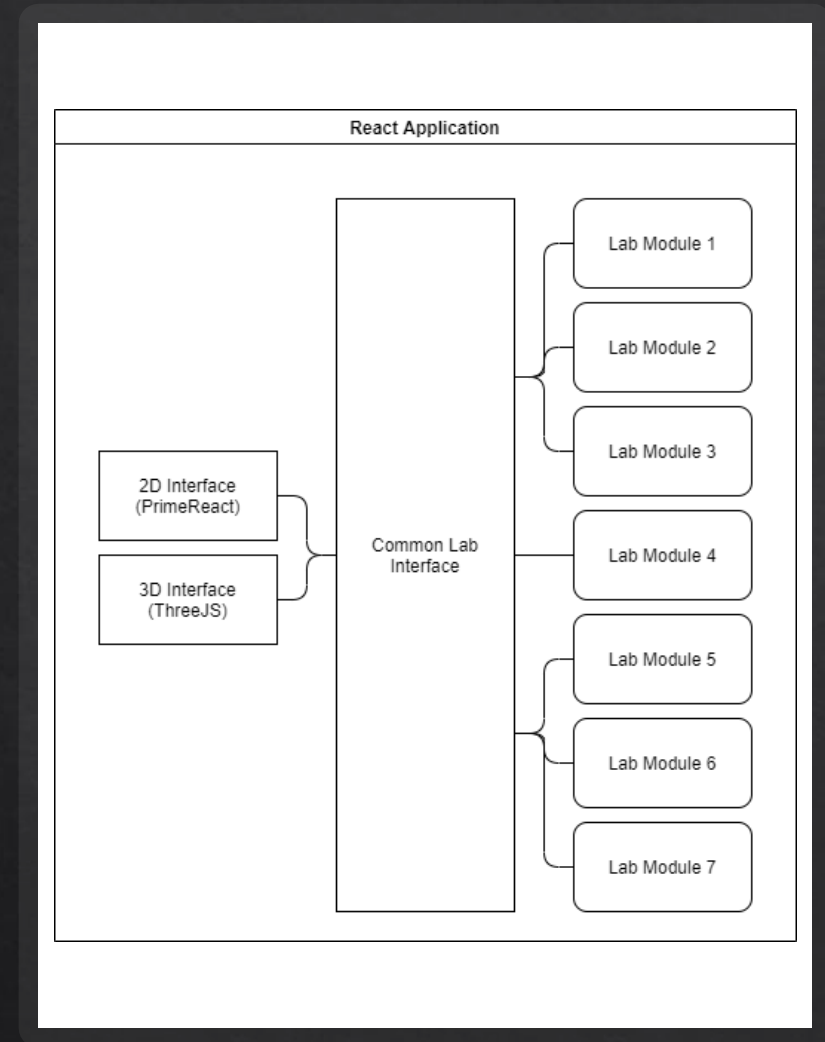
- ◇ A 2D variation of the lab was developed by an earlier development team.
 - ◇ It is still a work in progress
- ◇ Many features of the 2D lab were used as a reference or entirely reimplemented into our 3D lab environment:
 - ◇ Notebook graph design
 - ◇ Math commands
 - ◇ User interface formatting



Screenshot of the 2D lab program

Design

- ◇ React is used as the main framework to tie everything together
- ◇ PrimeReact is used for the 2D components
- ◇ ThreeJS is used for rendering and interacting with the 3D scene
- ◇ Each lab module is a separate React component which interacts with the 2D and 3D components



Visualization of the application's architecture

Recorded Demonstration

The screenshot shows a web browser window with the address bar at localhost:3000. The page title is "BBMB 102 Virtual Laboratory". Below the title, a welcome message reads "Welcome, Select an experiment to start." The main content area features six experiment modules arranged in a 2x3 grid. Each module has a title and a short description. The browser's address bar and various extension icons are visible at the top.

localhost:3000

BBMB 102 Virtual Laboratory

Welcome, Select an experiment to start.

Module 1: Protein Concentration Determination

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Module 2: PH and Buffers

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Module 3: Size Exclusion Chromatography

Determine the molecular weight of an unknown protein sample through an experiment involving a gel filtration column and a selection of known proteins.

Module 4: Enzyme Kinetics

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Module 5: Extraction and Analysis of Carotenoids

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Module 6: Plasmid DNA Purification and Analysis

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Testing Process (1/3)

- ◇ React Testing Library
 - ◇ Library for testing React components
 - ◇ Tests are designed to reproduce the behavior of the react application
 - ◇ We created events (i.e., click event) in the react-dom to simulate the lab's steps
 - ◇ We made use of functions in the library to assert the expected behavior against the actual

Result:

- ◇ Most tests passed as expected
- ◇ Failed tests were related to importing the Three Js library

Testing Process (2/3)

- ◇ Manual Testing
 - ◇ Each team member was assigned a certain number of feature to develop
 - ◇ Before demonstrations, each member was responsible for ensuring that their part was working correctly
 - ◇ In this phase, developers also look for defects in their implementation
 - ◇ In the presence of defects, the developer resolve the issue before the demonstration

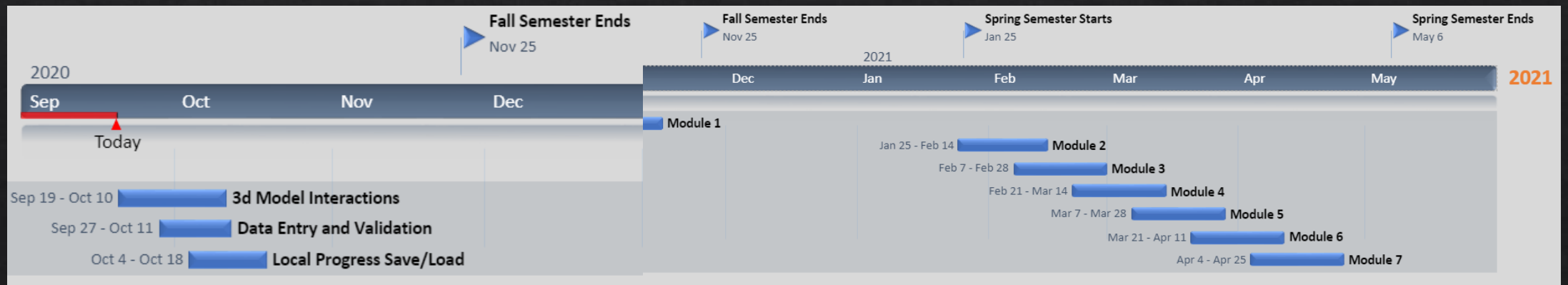
Testing Process (3/3)

- ◇ Acceptance Testing
 - ◇ We had demonstrations of current progress every two weeks
 - ◇ The demonstration is a way to get feedback from the client
 - ◇ The team carefully reviewed and resolve any critics or feedback
 - ◇ A 'pass' in this stage ensures that the client has accepted the current progress and is ready to move onto the next iteration



Reflections

- ❖ The original client's project design called for 7 modules. At the end of F20, we reduced it to 3, and then again to 1. We expected much more from ourselves than we produced.
- ❖ We should have spent much more time in a non-concrete design phase, so that a common architecture was understood, could gain complexity over time, and could be adapted later.
- ❖ Our project also required more familiarity with our frameworks (React, Three, ReactThreeFiber) than we expected.



Lessons Learned

- ◇ Start small, then extend: Planning everything in detail from the beginning was a mistake because our goals were not precise enough for short-term work to effectively take place.
- ◇ Everything takes longer than we think
 - ◇ It is hard to estimate how much time a feature will take given the requirements we were given
- ◇ Goals should be tailored consistently based on progress; not on initial idea of project.
- ◇ Should try different approaches at first to find better development routes that work for the whole team.
- ◇ Especially when working in a team, having a strong central architecture design is vital.



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