

Requirements Specification

December 1st, 2023

Version 2



Sponsored by: Dr. Elise Donovan, Sneha Vissa, Adonna Rometo

Mentor: Italo Santos

Team members: Dayra Quinonez, Nicole Sylvester,
Rino De Guzman, Bailey Rosato

Accepted as the baseline requirements for the project.

For the client: Elise Donovan For the team: Nicole Sylvester

Table of Contents

1. Introduction	4
2. Problem Statement	5
3. Solution Vision	7
3.1 Course Access Page	7
3.2 Content Menu Page	8
3.3 Interactive 3D Modeling	8
3.4 Display Course Content	8
3.5 Exporting Models	8
3.6 User Guide	8
4. Project Requirements	9
4.1 Functional Requirements	9
4.1.1 Content Display and Interaction	9
4.1.2 Unit Selection Menu	10
4.1.3 Export/Save the 3D Model	10
4.1.4 Data Storage and Management	11
4.1.5 User Guide	12
4.1.6 Internet Connectivity	13
4.2 Performance (Non-Functional) Requirements	13
4.2.1 Content Display and Interaction	13
4.2.2 Unit Selection Menu	14
4.2.3 Export/Save the 3D Model	14
4.2.4 Data Storage and Management	14
4.2.5 User Guide	15
4.3 Environmental Requirements	15
4.3.1 Web Application User Manual	15
4.3.2 Professionally-Documented Codebase	15
4.3.3 An Extensible Product	16
5. Potential Risks	17
5.1 Incorrect Data Displayed to the User	17
5.1.1 Model-Mismatch Error	17
5.1.2 Term-Definition Mismatch Error	17
5.1.3 Pathologies-Definition Mismatch Error	17
5.2 Incorrect Data Stored	18
5.3 Server Outage	18
5.4 Login Issues/Bugs	18
6. Project Plan	20
7. Conclusion	22

8. Glossaries and Appendices**23****9. References****24**

1. Introduction

The medical industry heavily relies on the learning material that comes from Anatomy and Physiology [2]. NAU's BIO 201 course is a fundamental requirement for medical students as it teaches students the structure and function of the human body. However, there is currently a lack of diversity in educational material for future healthcare workers which affects the quality of patient care and impedes diversity and inclusivity in the healthcare industry. Without a range of different models and diagrams, the educational aspects of healthcare are limited to generic, white, and skinny models. It is not ideal for future medical students to be lacking in a diversified education. This leads us to the biggest impact on this issue; healthcare professionals misdiagnosing patients since they do not know what a certain medical condition may look like on a person who does not look like the models that they have been studying for years [2].

If students at NAU, who are taking BIO 201, are able to absorb information through other models that are not the generic ones that are mass produced, there will be a significant difference in how students learn human biology. The impact of this solution will lead to NAU graduates being well-versed and prepared to serve a diverse population. NAU's classroom material will be inclusive and diverse for prospective students. Enrollment for a BIO 201 course ranges from 350 to 800 students, depending on the semester and the amount of sessions that are being offered.

Our clients, Dr. Elise Donovan, Adonna Rometo, and Sneha Vissa are professors in the Department of Biology Sciences and are all members of the Biological Sciences DEIJ Committee. The DEIJ Committee is an organization dedicated to fostering change in the fields of diversity and inclusion. As coordinators of the anatomy and physiology courses, our clients have evaluated their courses and recognized the lack of diversity that the models provide for students. They understand the importance of inclusivity and aim to incorporate it into their curriculum. Our main goal is to provide a web application that will display accurate three-dimensional models that will be capable of being adjusted by the students. This will allow students to change the sizes and skin tones of the models. These diversified models will offer a new study tool that students will be able to customize and learn from. The application will focus strictly on the material being taught in Biology 201: Anatomy and Physiology.

2. Problem Statement

The sponsor's key business workflow in order to teach BIO 201 students anatomy and physiology will be described below. First, the clients prepare the material they plan to teach by gathering physical and pictures of anatomical models they have at their disposal. Second, the clients introduce students to the material in a lecture style class where students are exposed to the content and anatomical models that demonstrate the content. Third, the clients allow students to better familiarize themselves with the material by providing assignments for students to study the content in readings and anatomical diagrams. Then, the clients have the students practice what they have learned in a lab setting, viewing a specimen under a microscope, identifying the specimen using provided models and diagrams, then drawing what they observe. Lastly, the clients test students on the content they learned in the form of a unit test where students answer diagram labeling questions. This process, demonstrated as a diagram in Figure 2 allows them to teach students anatomy and physiology, important to patient care and treatment, which is the core of their profession.

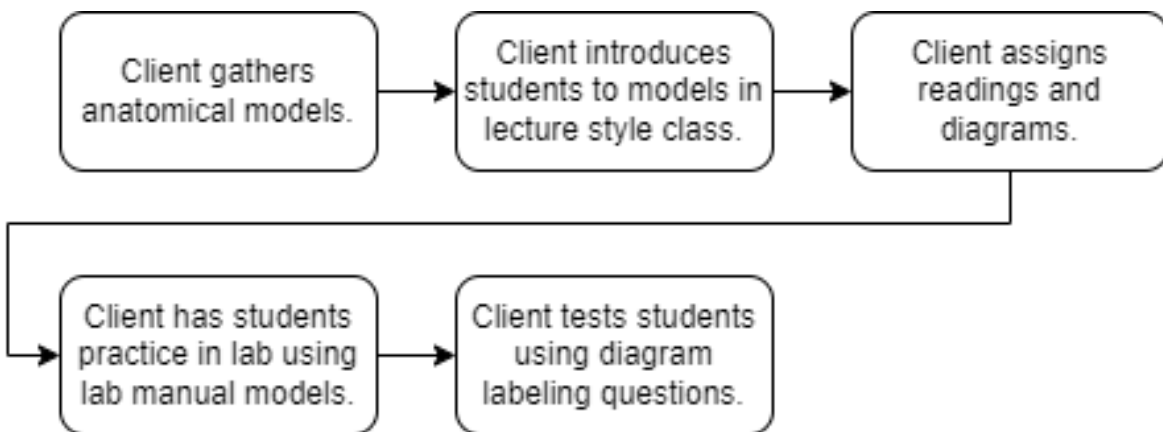


Figure 1: Client Workflow

As you can see from the diagram, at every stage of the learning process, students are studying anatomical models. However, these models tend to be generic, skinny, and white. Currently, there is a lack of diversified anatomical models within our clients' anatomy and physiology courses and the material they can provide to students. The only non-white model the department owns is a poorly represented torso model, and since more diversified and complex models are unproduced and overly expensive, the clients have few options. This affects the quality of patient

care, limits students' educations, and fosters feelings of underrepresentation. The following are the specific deficiencies our clients are currently facing.

- Lack of diversified models, current models are skinny, white.
- Diversified models are hard to find and not many are produced.
- Diversified physical or software based models are expensive.

Our clients recognize the deficiencies in their current approach and are actively working to make positive changes. Therefore, our team plans to address these deficiencies in the current workflow to create a more inclusive and better representative approach to Northern Arizona's BIO 201 curriculum.

3. Solution Vision

To acknowledge the lack of diversity in the BIO 201 curriculum, our goal is to develop an interactive web application that allows students to tailor their anatomical models to represent a range of body types and skin tones. This application's goal is to facilitate a greater understanding of the material and inclusivity. Users will be able to adjust several features of the body and a model will be generated in real-time for users to reference in their studying of the material. Users will also be able to manipulate the view of the model and once finished, they can export the model to use offline.

The initial iteration of this application is designed to assist BIO 201 students with course content for the first unit of class. With further development, our software will prevent the Biological Sciences Department from spending money on expensive models that only cater to a small portion of the students, thus allowing them to focus more on diversifying content to better serve their students. Introducing diverse modeling to an introductory anatomy and physiology course will give students greater exposure to real world scenarios and prepare them for applicational skills in their careers. This is significant in resolving issues of misdiagnosis due to lack of proper educational materials for future health care professionals.

Our system will change how the BIO 201 material is taught to students - they will now have more accessibility to diverse models that are relevant to their education. Furthermore, our clients will not have to settle for a limited amount of poorly constructed physical models that are expensive. Although our system does not have a physical element that some students rely on when learning, it does address concerns of accessibility and diversity that the other products do not.

The following are the main features of our web application with a brief description. Figure 2 presents a diagram that displays how these features interact with each other.

3.1 Course Access Page

- Students enrolled in BIO201 will be provided with a course code to enter to access the web application. This limits the number of users to the amount of BIO 201 students per semester.

3.2 Content Menu Page

- Students will be able to navigate the application by selecting the appropriate content unit and subsections. Each page will contain content that is specific to the selected unit to allow students to study specific content.

3.3 Interactive 3D Modeling

- Our product will generate 3D models of the body and these models will be used by students and instructors to expand the breadth of material diversity. Instructors will use this tool to demonstrate to students key learning outcomes and students will be able to use it as a studying tool.

3.4 Display Course Content

- The data used to generate these models comes from preexisting libraries of 3D body models and the course curriculum as provided by the clients. To ensure that the web application is tailored to the client's curriculum, we will be working closely with our clients and checking that it will be functional as a lab resource.

3.5 Exporting Models

- To reduce issues of accessibility, students will have the option to export models after they have made all their desired changes.

3.6 User Guide

- To learn how to use the application and its modeling tools, users will be provided with a User Guide that provides a tutorial for the layout and content of the page as well as a guide for accessibility and compatibility.

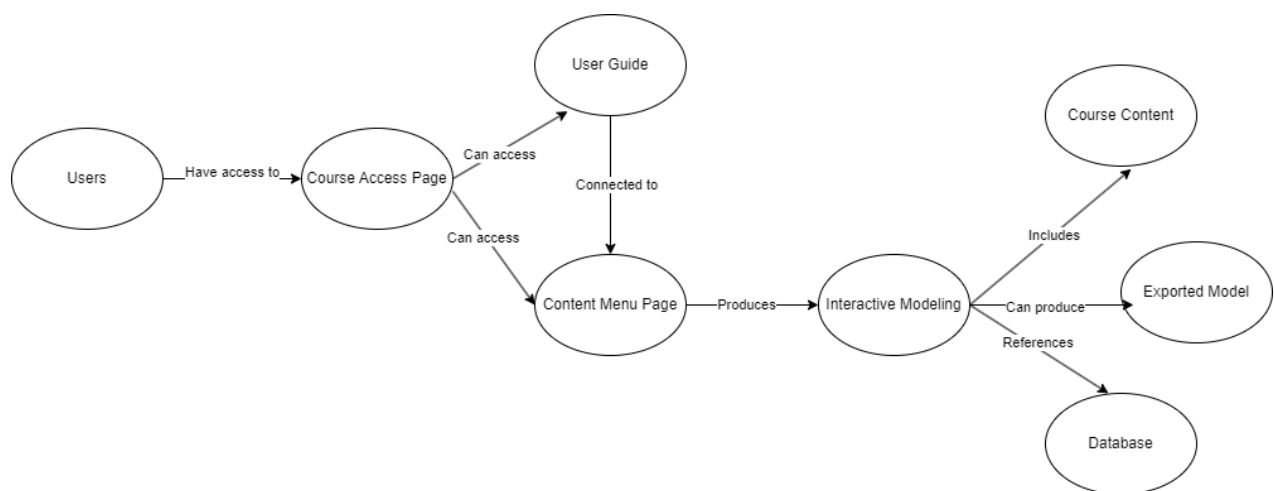


Figure 2: The interactions between key features of our proposed 3D modeling web application.

4. Project Requirements

There are three categories of requirements our team will consider for a successful project. Functional requirements are the functions that our application will need to do. Non-functional requirements are metrics for how those functional requirements will perform. Lastly, environmental requirements are constraints imposed on our project. These three requirements are evaluated below.

4.1 Functional Requirements

Functional requirements are detailed descriptions of what the application should do. These requirements specify the functions and features that the application must provide in order to meet the clients needs. The following sections detail the specific requirements our application will provide and will decompose high level requirements in order to better understand what goes into each functional requirement.

4.1.1 Content Display and Interaction

The application will display 3D models and educational content specific to NAU's BIO201 unit information. Models will be rendered on the user interface and allow users to utilize user interface elements in order to adjust features of their model. Users will also be able to interact with the 3D model through zoom and rotate features. Educational content specific to the unit will accompany the model and provide important terminology.

- **3D Model Rendering**

The application will display the rendered 3D model in the model display area of the user interface. The model display area will be located to the left of the course content and adjustment features.

- **Model Adjustment**

The application must allow users to adjust the gender of a model using a switch. As the switch is flipped, a new model will be generated. The skin tone and body size should be adjusted using sliders. Sliders will have predesignated increments that users will slide to and a new model will be generated.

- **Model Interactivity**

The application will be capable of displaying adjusted perspectives of the model, such as zoom and rotation. Users will be able to zoom in on the models to see details of

anatomical locations or boundaries. Users will be able to rotate the model along the x-axis, displaying all angles of an upright model. There will also be rotation along the y-axis, allowing users to look at models from top-down or bottom-up.

- **Educational Content**

The application will display educational content and terminology specific to the BIO 201 unit materials to accompany the 3D model. This content must be accurate and relevant to the model being displayed. All biology content will be cross-checked with an official BIO 201 Laboratory Manual and with our clients.

4.1.2 Unit Selection Menu

Since this application is specific to NAU's BIO 201 course, the application must include flexibility for adding units beyond the first one in the future. In order to facilitate multiple units, our application must have a menu. This menu will allow users to navigate through the application with ease. When the user first enters the application, a large main menu will appear, while a smaller side menu will be accessible at all times in the top corner of the application.

- **Homepage Menu**

When users first enter their course ID, they will be taken to a main menu page. This menu will list all of the units available to students as well as an exploratory page that lets users make changes to a model without specific content and a user guide section that will be discussed later. When a user clicks on a section, they will be navigated to the corresponding unit. For the purposes of this project, we will only implement unit one materials but there will be other units as the application expands.

- **Sidebar Menu**

A sidebar menu will always be available to users to facilitate navigation while using the application. A hamburger menu will be located in the upper left corner of the web application pages. When clicked, it will display a menu, similar to the homepage menu, but on a smaller scale. This allows users to navigate pages easily without having to return to the main homepage menu.

4.1.3 Export/Save the 3D Model

In order for the application to be effective, users must be able to access their models for future viewing. Therefore, the application will offer export functionality that will allow users to export their 3D model in a couple supported formats, facilitated by the user interface.

- **Export Functionality**

A user should be able to export the 3D model in order to save it for future viewing. Users will be able to export the 3D model in different formats including the 3D object format OBJ and the 2D format PNG. Users can choose the export format through a user interface and the exported file should accurately represent the 3D model.

- **Supported Export Formats:** The application will support standard 3D file formats for export like OBJ and image format PNG.
- **Export Validation:** The exported 3D model or image will be error-free and high enough resolution that is compatible with the clients standards.
- **Real-Time Rendering:** The application will provide a real-time preview of the exported 3D model or image before exporting.

- **User Interface**

The user interface will facilitate exporting a model through the use of an export button located under the 3D model display. When the export button is clicked, JavaScript captures the 3D model canvas data and creates a downloadable PNG or OBJ image.

- **User-Friendly:** The application will provide an intuitive and user-friendly interface for exporting and saving 3D models. The interface will stay consistent across pages and exporting will be covered and explained in the user guide.
- **Error Handling:** The application will handle errors and provide informative error messages when issues arise during export. These error messages will be descriptive enough for the user to understand and possibly fix the error.

4.1.4 Data Storage and Management

The web application must include a functional database that facilitates real-time changes in generating models per user adjustments. The administrator of the database is responsible for keeping the database updated and organized.

- **Real-Time Changes**

The application will be capable of updating changes to the model in real-time. As the user moves the slider of the adjustable traits, these changes will be reflected in the model.

- **Data Retrieval**

The application will retrieve customized model configurations from the database and use them for the appropriate slider position.

- **Data Storage**

The database of the application will be organized into model data, content data, and other application data to reduce redundancy.

4.1.5 User Guide

The web application must include a user guide with tutorial features to ensure a user-friendly experience for all users. In order to provide an effective user guide, the tutorial must be easy to navigate through, include headings and subheadings, provide instructions for essential features, offer assistance to users, and be accessible and compatible with a range of users.

- **Content and Layout**

The user guide will be laid out in an easy to understand way and the content covers essential functions of the application and uses user friendly terminology and visuals.⁶

- **Tutorial Layout:** The application's user guide will be laid out in a document that will contain a table of contents, heading, and subheading for the specific features. The tutorial will be easy to navigate and we will be located at the bottom of the list of menu items. This will provide quick access tutorials to guide users through various features.
- **Tutorial Content:** The user guide will cover essential functions of the application including model customization, exporting, and navigation. The content will be designed with an educational perspective in mind to support the learning of students. Both written explanations and pictures will be included in order to better explain the key features. The visuals and text will be clear, concise, and user friendly.

- **Assistance**

The user guide will offer assistance options in case users encounter difficulties. Assistance will be provided in the form of a faculty email and/or NAU ITS contact information.

- **Accessibility and Compatibility**

The application will provide a downloadable step-by-step PDF tutorial kit that will cover essential functionalities to allow users to have both the instructions and application open at the same time. This will ensure that the user guide is accessible to a wider range of users and compatible with different devices. This feature aims to enhance usability of the

application, contributing to a better educational experience for students and ensuring that they can effectively utilize the tool for their learning needs.

4.1.6 Internet Connectivity

The web application relies on a stable internet connection to ensure functionality and optimal user experience. Internet connectivity plays a role in real-time updates and database interaction.

- **Real Time Updates**

The application requires a consistent and reliable internet connection to enable real-time updates to the 3D model as users make adjustments.

- **Database Interaction**

Internet connection is essential for the application to retrieve model configurations from the database and apply them based on the user's interaction with the UI elements. Users must be connected to the internet in order for the application to fetch and apply data from the database.

4.2 Performance (Non-Functional) Requirements

4.2.1 Content Display and Interaction

- **3D Model Rendering**

- The application will display the rendered 3D model in 2 seconds.

- **Model Adjustment**

- The application will switch genders when the switch is triggered within 1 second.
- The model will be generated within 2 seconds.
- The application will make modifications of the model through the sliders in real-time.

- **Model Interactivity**

- The application will be able to zoom in and out of the model no longer than 0.5 seconds.
- Rotations should also be real-time so it should not take any longer than 0.5 seconds.

- **Educational Content**

- When the educational content is pressed on the content should be displayed in 1 second.

4.2.2 Unit Selection Menu

- **Homepage Menu**

- After inserting the pass code for the semester then it should take no more than 2 seconds.
- When clicking on content sections, the unit material should drop down within 1 second.

- **Sidebar Menu**

- As the hamburger menu is clicked on the drop down menu should appear.

4.2.3 Export/Save the 3D Model

- **Export Functionality**

Supported Export Formats:

- As all technologies are different and may take longer than others, the export can take from 30 seconds to 2 minutes.

Export Validation:

- The image produced will be error-free and high resolution.

Real-Time Rendering:

- When clicking on the export button within a second a display should appear asking the user if they are exporting in 2D or 3D format.

- **User Interface**

- **Error Handling:**

- The application will provide informative error messages within 2 seconds of error occurring.

4.2.4 Data Storage and Management

- **Real-Time Changes**

- As buttons and sliders are pressed and dragged, the model should be modified within 0.1 seconds.

- **Data Retrieval**

- The application will retrieve customized model configurations within 30 seconds.

- **Data Storage**

- The database of the application will be organized into model data, content data, and other application data within 1 minute.

4.2.5 User Guide

- **Content and Layout**

- **Tutorial Layout:**

- The download of the PDF document will depend on the device of the user. If the device is faster it should take 15 seconds to download, but if it is a slower device then it can take up to 1 minute.

- **Tutorial Content:**

- Users will understand the functionality of the application within 5 to 15 minutes. Users who are familiar with these types of applications will take around 5 minutes to understand how it works. However, for users who are not familiar, it may take about 15 minutes to get through the application.

- **Accessibility and Compatibility**

- Will be downloadable in a variety of devices.

4.3 Environmental Requirements

In order to tailor the solution to the specific needs of the clients beyond the basic performance and functionality requirements, a number of constraints and requirements were imposed.

4.3.1 Web Application User Manual

As this is a product that is going to be used by many students and instructors, it is very important, as with any application, that there is a User Manual for the users to reference. The user should be able to learn from the User Manual and discover the features that the web application has to offer. The User Manual will include instructions on how to get quickly started with the application, any setup that is required, descriptions of features, and nuances of the program.

4.3.2 Professionally-Documented Codebase

In order for this application to be successful and be built upon smoothly in the future, it is important that there is a professionally-documented codebase in GitHub and as a physical archive on a USB drive. This will ensure that the application is appropriately stored and copied in multiple locations/formats. Having a professionally documented codebase allows the clients to keep track of the application and allow opportunities for future expansion.

4.3.3 An Extensible Product

It is of utmost importance that the product is designed in such a way that allows future content to be added and integrated. As an application that will be used as a supplementation to the BIO 201 curriculum, it is important that it has the ability or potential to contain all the content from the curriculum. In order to accomplish this requirement, it was determined that the best solution would be to develop a modular codebase that is segmented organically. This will make sure that the structure of the code is simple and is easy to expand upon as new features are added and more code is written into the application.

5. Potential Risks

5.1 Incorrect Data Displayed to the User

Given that this project relies heavily on accurate models and scientific information, there is a potential susceptibility for risks that should be managed and remedied accordingly. A failure in rendering the correct models, terms, and pathologies to the user with the necessary relevant information from texts could spread inaccurate information within the BIO 201 curriculum. This failure would undermine the application's value of providing accurate standardized information within a diverse environment.

5.1.1 Model-Mismatch Error

Likelihood : Low

Severity : Medium

Within any application that involves the use of retrieving from a database, there will always be an opportunity for the wrong information to be retrieved. That is the case with this application. As the application is planned to have separate models for each subunit, with its own dedicated terms, pathologies, and definitions, it is important the user is interacting with the appropriate model within each unit or subunit.

5.1.2 Term-Definition Mismatch Error

Likelihood : Medium

Severity : High

As similar to above, there may be an opportunity in which a term is matched up with the wrong definition as a result of incorrect database retrieval. As the application will have many terms and definitions for each model, this will make it difficult to ensure that the right term is correctly associated with the belonging definition and is displayed on the appropriate model.

5.1.3 Pathologies-Definition Mismatch Error

Likelihood : Medium

Severity : High

As similar to above, there are possibilities in which a Pathology is matched and shown with the wrong definition as a result of incorrect database retrieval. There will be pathologies available to be shown through pop-up images or through the anatomical models. There may be situations in which the pathology described, does not match with the pop-up image or is incorrectly shown on the anatomical model.

To mitigate any of the above situations the team will normalize the database to Second Normal Form to eradicate insertion, update, and deletion anomalies.

5.2 Incorrect Data Stored

Likelihood : Low

Severity : High

Given that the web application's main value is the ability to be used as a supplemental resource in the BIO 201 curriculum, it is important that data of pathologies, terms, and definitions are correctly defined in the database. The risk of incorrectly importing data from educational text (lab manuals & textbooks) must be mitigated to prevent students from accidentally learning the wrong information. This can be done by creating tests to ensure the correct relationship between tables and attributes of data within the database.

5.3 Server Outage

Likelihood : Low

Severity : High

In the event that an outage has occurred in the hosting platform, this will cause users to be unable to interact with the web application. The likelihood of this occurrence is low as server hosting platforms have existing contingencies in the event that an outage occurs. Although, in the event that the outage is not properly managed by the server hosting service and is not fixed immediately, this will have a highly significant impact on the users. This will prevent users from being able to learn and study from the web application. Depending on the length and frequency of the outage, it may hinder the user's learning experience and grades. To mitigate this risk, we will allow users to export models, this will allow the students to be able to study without internet or in case of a server outage.

5.4 Login Issues/Bugs

Likelihood : Low

Severity : High

The likelihood of login issues is low as testing will be conducted to ensure that the chosen correct course code will appropriately bring the user into the home page of the application. Although, the severity of the issue is high due to the fact that if the user is unable to login to the web application despite having the correct course code provided, it will make the web application unusable for the user until the issue is resolved. This may hinder the user's learning experience and make the user less inclined to use the application in the future. As a mitigation strategy, we will have automated tests that ensure the course code appropriately brings the user to the course menu page.

6. Project Plan

Now that the key requirements have been discussed, and the mitigations towards the potential risks have been identified, the chart below displays the current plan of action for creating our BIO 201 Web Application.

Fall 2023



Figure 3: A Gantt Chart showing the Fall 2023 design timeline for BIO 201 Web application

Spring 2024

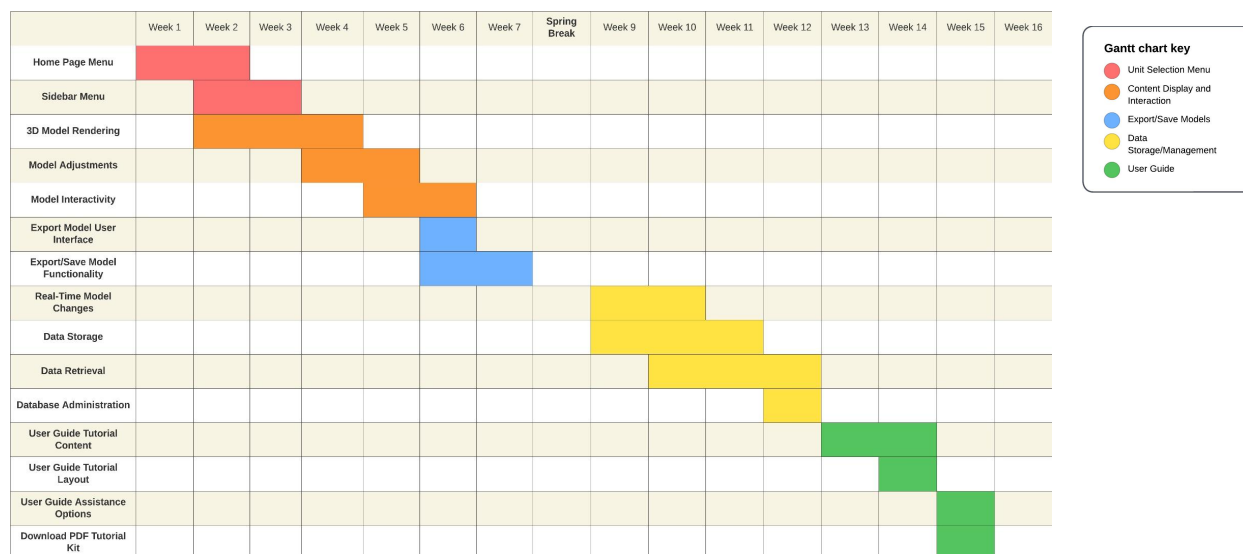


Figure 4: A Gantt Chart showing the Spring 2024 development timeline for the BIO 201 Web Application.

As can be seen in Figure 3, the entirety of the first semester is spent conducting research and gathering design details of requirements needed to accomplish the desired product for our clients. So far, the Technological Feasibility and the Requirements Specifications document provide a deep analysis of technologies to implement the application and the functional features that are required for the application. As the team is finishing up on the research and design of the BIO 201 Web Application in Fall 2023, the transition will slowly begin to start the implementation of the product. Spring 2024 will be focused on bringing the Web Application into fruition.

As shown in Figure 4, development will begin with creating the vital infrastructure. The Unit Selection Menu includes the Home Page and Sidebar Menu. The Application's Content Interaction and Display includes 3D Model rendering, Model Adjustments, and Model Interactivity. We are estimating that the Unit Selection Menu and Content Interaction/Display will cumulatively take 2-3 weeks to develop. After that the team will then be expanding into the back-end to establish the database (Database Storage/Management & Database Administration) which includes features such as Real-Time Model changes, data storage, data retrieval and database administration. The Database Storage and Management is estimated to have a development time of 4 weeks. Lastly, the User Guide is created to allow future users to begin using the application as smoothly as possible. The User Guide includes features such as Tutorial Content/Layout, Assistance Options, and a downloadable PDF Tutorial Kit, with an estimated development time of 3 weeks. An extra 2 weeks is left unassigned to allow for any deviations within the development process of the application.

7. Conclusion

Throughout the document, we have discussed the creation and implementation of a new application aimed at expanding inclusivity within the NAU Anatomy courses, starting with the BIO 201 course. The medical industry's lack of diversity is concerning, as it is a leading cause of misdiagnosis. There have been plenty of people who have suffered due to the lack of advancements in the models from which healthcare professionals learn.

Our solution is to create a web application that will serve as both a study method and a learning tool. Essentially, users will be able to create their own models, altering body shape and skin tones according to their preferences and curiosity. The goal is to be able to demonstrate realistic models beyond the generic models that the textbooks tend to display, white and skinny models. This solution will allow students of NAU to be prepared to serve a diverse population once they have graduated and entered the industry.

In this document, we have discussed our vision for this solution in depth. We have outlined the project requirements and the functions that will work together to create this web application. The ability to create, display, and modify three-dimensional models is key to this project. The application will also allow users to save and export files, preserving the models and notes they have created. In addition, we aim to ensure that the application is user-friendly and can manage a class on the application simultaneously without affecting the performance.

Our team has conducted extensive research to identify technologies that would be suitable for us and optimal for the web application. We are currently working on creating prototypes and a demo that will essentially be creating our prototype interactive. The next steps involve taking what we have learned and beginning to implement it, starting with the creation of the web application front end and implementing the three-dimensional models that we will be creating.

8. Glossaries and Appendices

BIO 201 - Human Anatomy and Physiology 1: Integumentary, skeletal, muscular, nervous, and sensory systems in health and disease.

DEIJ - Diversity, Equity, Inclusion, and Justice

9. References

- [1] Dodd, Rebecca V, et al. “The Impact of Patient Skin Colour on Diagnostic Ability and Confidence of Medical Students.” *Advances in Health Sciences Education : Theory and Practice*, U.S. National Library of Medicine, Oct. 2023, www.ncbi.nlm.nih.gov/pmc/articles/PMC9977083/.
- [2] “Turn Your Biology Major into a Medical Degree.” *Drury University*, 4 Apr. 2023, www.drury.edu/pre-health/turn-your-biology-major-into-a-medical-degree/#:~:text=Required%20Courses%20for%20Medical%20School&text=Common%20class%20requirements%20for%20medical,suit%20their%20chosen%20medical%20field.