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CENG 407 – Product Vision & Scope

VR Anatomy: VR Based Educational Interactive Human Anatomy Training Platform

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Table of Contents

1. Overview

1.1. Purpose

This report has been prepared to present the product vision and scope of the VR Anatomy project in a clear, measurable, and verifiable manner. The document explains the educational need the project addresses, the characteristics of the target user group, and the requirements under which the application will be used, thereby outlining the project's objectives. Within this framework, the report defines the system's main features and demonstrates how these features are linked to user needs.

In addition, the report captures the key actions users are expected to carry out in the application through a set of user stories. Each user story is supported with clear acceptance criteria that define what conditions must be met for the related functionality to be considered complete. This helps the team translate the vision into concrete development goals and provides a consistent reference point during implementation, testing, and evaluation.

Furthermore, the document specifies the project's scope boundaries by explicitly stating both the topics the team will focus on and those that are excluded from the scope. This clarifies expectations and provides guidance for potential future extensions.

1.2. Product Summary

VR Anatomy is an interactive educational application designed to help students who are health vocational high school students learn human anatomy more clearly and retain it more effectively in a virtual reality environment. The application aims to enable students to learn by experiencing, within VR, the three-dimensional form and basic relationships of anatomical structures that are difficult to grasp through two-dimensional textbook/atlas images. Rather than replacing existing resources, the system is positioned as a complementary tool and provides an immersive learning experience focused on selected anatomical systems.

VR Anatomy uses a modular content structure. Upon launch, the student selects the anatomical system to study from a main menu in VR, after which the relevant scene, 3D models, and learning content are loaded. To keep the initial release feasible, the project focuses on a limited set of anatomical areas, enabling a manageable initial version while still offering a clear learning path. Inside the VR environment, students explore a central 3D anatomical model using basic XR interactions. When a structure is selected, it is highlighted and an information card appears within the user's view, presenting the structure's name and a brief description. Students can manipulate the model to strengthen spatial understanding, and they can reinforce learning through short quizzes that provide immediate feedback.

Educational content including structure descriptions and quiz questions is delivered through JSON-based content files packaged with the application, supporting organized content management and easier future expansion. The system also includes an optional RAG-based AI Tutor that answers student questions using the provided learning materials.

2. Product Vision

2.1. Vision Statement

VR Anatomy enhances anatomy learning in VR through interactive 3D exploration, clear structure-based explanations, and optional tutoring support to help students learn faster and retain knowledge longer.

2.2. Problem and Opportunity

Anatomy education still relies heavily on two-dimensional materials such as textbooks, slides, and diagrams. Because of that, students may find it difficult to build an accurate mental model of anatomical structures especially when trying to understand the true shape of bones and organs, their depth, and how different structures relate to one another in space. When students' questions are not answered promptly and reliably during the learning process, the learning flow can be interrupted. In addition, limited access to physical models or laboratory materials can reduce opportunities for detailed, hands-on exploration.

This creates an opportunity for a VR-based learning approach. Virtual reality enables students to view anatomical structures directly in 3D, inspect them closely, and explore spatial relationships more intuitively than with 2D resources. In VR Anatomy, selecting a structure provides clear visual feedback and opens a concise information card within the user's field of view. Combined with basic XR interactions such as selecting, grabbing, rotating, and examining from different angles learning becomes more active and structured, supporting both recognition of structures and understanding of their spatial context.

When available, the AI Tutor further supports this process by letting students ask short questions and receive immediate explanations without leaving the VR environment. Since responses are grounded in the project's prepared learning content, the system aims to keep explanations consistent with the scope and terminology of the course materials.

2.3. Value Proposition

2.3.1. For Students

VR Anatomy supports students in understanding and retaining anatomy by enabling interactive 3D exploration in a VR environment. Instead of relying only on 2D materials, students can examine structures from multiple angles, build stronger spatial understanding, and follow a more organized study flow through clear, structure-focused information shown at the moment of interaction. Learning is further reinforced through short self-assessment activities that provide immediate feedback. When available, the optional AI Tutor offers quick, content-based explanations without requiring students to leave the learning context.

2.3.2. For Instructors

For instructors, VR Anatomy can function as an interactive demonstration and support tool during lessons or guided practice sessions. The modular structure allows instructors to focus on specific systems aligned with lesson objectives, while the 3D environment helps communicate spatial relationships that can be difficult to convey with static visuals. In this way, the application complements existing teaching materials and can help students stay engaged and oriented while reviewing key structures.

3. Target Users and Context

3.1. Users

3.1.1. Primary Users

The primary target users of VR Anatomy are health vocational high school students who study anatomy at an introductory level. This group typically needs support in forming an accurate 3D understanding of anatomical structures, including their shape, spatial relationships, and basic structure areas that can be challenging to grasp through 2D materials alone. Students also benefit from a guided learning flow that helps them stay oriented while exploring unfamiliar content and reinforces key concepts through short, clear explanations and practice activities. In addition, an optional AI Tutor that provides content-based question-and-answer support can further assist students during self-study by offering quick clarification without interrupting the learning process.

3.1.2. Secondary Users

Instructors are identified as the secondary user group of VR Anatomy. Their main contribution is to support students during classroom or laboratory sessions by guiding the

learning flow and helping the group stay focused on the intended topic. Instructors guide the session externally and are not required to interact with the VR interface directly.

3.2. Usage Environment

The application is designed as a virtual reality learning experience intended for short and controlled sessions in educational settings. A typical usage scenario takes place in a school VR or simulation laboratory, a computer lab, or any other area suitable for safe VR use. In the current setup, the application is intended for single user sessions and does not support simultaneous use by multiple students on the same device. In addition to individual study sessions, the application can also be used in a classroom demonstration setting led by an instructor. VR Anatomy is delivered as a Unity based VR application that runs on supported VR hardware. Students interact with the environment through standard VR controller inputs to select modules and explore anatomical content. Key interface elements such as information cards, quizzes, and the optional AI support panel are displayed within the VR view in a clear and readable format to guide the learning flow.

3.3. Assumptions and Constraints

The project assumes that students can learn basic VR controller operations with brief guidance and that the user interface can be kept simple and clear enough to support learning rather than distract from it. The application is intended for educational use and is not designed for clinical or diagnostic purposes. If the AI Tutor feature is enabled, another assumption is that responses will be based on the learning content provided within the project scope so that explanations remain aligned with the intended curriculum focus. It is also assumed that content will be developed incrementally, meaning the first release will include a limited and modular set of topics that can be expanded in later releases.

The main constraints of the project are budget, time, and content production capacity. Producing anatomy content requires preparing and validating 3D models, optimizing them for VR performance, and linking them with educational descriptions and assessment items, which directly impacts the development timeline. In addition, VR comfort and performance requirements limit scene complexity and asset size, so the system is designed to load content per module rather than keeping all assets active at the same time. Finally, the AI Tutor depends on prepared data, retrieval components, and external service availability. Therefore, AI functionality and response quality may be affected by connectivity and resource limitations.

4. Main Features

4.1. Module Selection and Navigation

VR Anatomy uses a module based structure to divide anatomy content into manageable learning units. When the application starts, the student selects the module to study from a main menu in the VR environment. After a module is selected, the corresponding scene, 3D models, and module specific learning content are loaded.

Within a module, the student can use basic navigation controls to maintain a smooth learning flow, including returning to the main menu, switching to another module, and ending the session when needed. During loading and transitions, the application provides clear on screen feedback so users understand that content is being loaded and do not lose context.

4.2. 3D Exploration

The application enables comfortable 3D exploration in VR so that students can better understand the shape of anatomical structures and their spatial relationships. Students can adjust their viewpoint within the scene in a safe and controlled way to observe the model from different angles. They can also inspect details by moving closer to the structure or stepping back to view it as a whole. To support VR comfort and safe use, movement is designed to be controlled and limited, educing the risk of discomfort and helping users stay oriented during exploration.

4.3. Interaction

VR Anatomy's learning experience is centered on direct interaction with anatomical structures. Using VR controllers, the student can point to a structure and select it, after which the system highlights the selection to make it clearly identifiable. When supported by the module, the student can then manipulate the structure through actions such as grabbing, releasing, and rotating it to inspect it from multiple angles.

These interactions encourage active exploration and make it easier to understand a structure's form and key visual features, supporting stronger spatial understanding compared to relying on two-dimensional materials alone.

4.4. Labels and Info Cards

To support quick and clear learning of anatomical structures, VR Anatomy presents structure based labels and information cards. When a student selects a structure, the system displays its name and a short description in an information card that is easy to read within the VR environment. The text is kept brief and level appropriate so it can be understood without interrupting the exploration flow.

The information card is positioned to remain visible while minimizing obstruction of the main 3D view. Content shown on the card is retrieved through the mapping between each structure and its associated learning content, which is loaded together with the selected module.

4.5. AI Tutor

The application includes an AI Tutor feature to help students quickly clarify questions without leaving the learning flow. Students can submit questions through an in VR panel, and the system generates short educational explanations based on the learning content provided within the scope of the project. This helps keep answers aligned with the module content and terminology.

4.6. Quiz Mode

To reinforce learning, VR Anatomy provides a dedicated Quiz Mode that can be accessed directly from the main menu at any time. This mode is independent from the module exploration experience, meaning students may choose to solve questions without entering a module, or explore modules without completing quizzes.

In Quiz Mode, multiple choice questions are displayed on a VR panel. The student selects an answer using the controller and submits the response through a simple confirmation interaction. After submission, the system immediately provides correct or incorrect feedback to support quick self evaluation. Quiz content is drawn from module specific question pools.

4.7. Review Mode

In this mode, only the assets of the selected anatomical model are displayed, allowing the user to manipulate the model freely through standard VR interactions such as moving, rotating, and inspecting from different angles. Unlike the standard learning flow, Review Mode does not display information cards or automatic explanatory text. This enables instructors, as

secondary users, to deliver their own explanations and guide students through the content in a way that matches their teaching plan.

5. User Stories

The following user stories define the core goals that the VR Anatomy application will provide for high school students and teachers. For each story, the acceptance criteria specify the observable conditions required for the feature to be considered done.

5.1. Student User Stories

US-S01 Module Selection

- **Role:** Student
- **Goal:** Select an anatomy module to study.
- **Benefit:** Focus on a specific topic.
- **Priority:** Must-have
- **Acceptance Criteria:**
    - **AC1:** When the application launches, a main menu is displayed in VR and available modules are listed.
    - **AC2:** When the student selects a module, the corresponding scene and module content are loaded and ready for interaction.

US-S02 In-Module Navigation

- **Role:** Student
- **Goal:** Return to the main menu and switch modules without closing the application.
- **Benefit:** Maintain a continuous learning flow.
- **Priority:** Must-have
- **Acceptance Criteria:**
    - **AC1:** While inside a module, the student can access an option to return to the main menu.
    - **AC2:** After returning to the main menu, the student can select another module and load it successfully.

US-S03 - Anatomical Structure Selection

- **Role:** Student
- **Goal:** Select an anatomical structure in VR.
- **Benefit:** Clearly identify the structure the student is examining.
- **Priority:** Must-have

- **Acceptance Criteria:**
  - **AC1:** The student can select a structure using VR interaction input available in the application.
  - **AC2:** When a structure is selected, the system provides a clear visual indication of the selection.

US-S04- Grab & Inspect (Holding and Examining a Structure)

- **Role:** Student
- **Goal:** Examine a structure from different angles.
- **Benefit:** Better understand the structure's 3D form and spatial details.
- **Priority:** Must-have
- **Acceptance Criteria:**
  - **AC1:** Supported structures can be grabbed and released using VR controller input.
  - **AC2:** While grabbed, the structure can be rotated and inspected from multiple viewpoints.

US-S05- Labels & Info Card

- **Role:** Student
- **Goal:** View the name and a short description for a selected structure.
- **Benefit:** Quickly learn basic information without breaking the study flow.
- **Priority:** Must-have
- **Acceptance Criteria:**
  - **AC1:** When a structure is selected, its name is displayed clearly in the VR environment.
  - **AC2:** An information card displays a short, level appropriate description for the selected structure.
  - **AC3:** The information card can be closed by the student.

US-S06- Asking a Question to the AI Tutor Chat

- **Role:** Student
- **Goal:** Open the AI Tutor Chat for the selected module and ask questions.
- **Benefit:** Get quick explanations while studying the module content.
- **Priority:** Must-have
- **Acceptance Criteria:**
  - **AC1:** The student can open the AI Tutor panel within the application.
  - **AC2:** The student can submit a question using an available VR input method.

o **AC3:** The system displays the AI Tutor response in a readable format within VR.
o **AC4:** Responses are based on the project provided learning content and remain aligned with the module scope and terminology.
o **AC5:** If no relevant content is found, the system returns a clear message indicating that information is not available in the current dataset.
o **AC6:** The AI Tutor provides educational explanations only and does not provide diagnosis, treatment, or medical advice.

US-S07- Quiz Mode Access

- **Role:** Student
- **Goal:** Access Quiz Mode to reinforce knowledge
- **Benefit:** Enable quick self-assessment on specific topics.
- **Priority:** Must-have
- **Acceptance Criteria:**
    o **AC1:** Students can access Quiz Mode directly from the main menu.

US-S08- Answer and Feedback in Quiz Mode

- **Role:** Student
- **Goal:** Solve multiple choice questions and receive immediate feedback
- **Benefit:** Identify what students know and need to review
- **Priority:** Must-have
- **Acceptance Criteria:**
    o **AC1:** The student can select an answer and submit it within the quiz interface.
    o **AC2:** After submission, the system provides correct or incorrect feedback immediately.

US-S09- Review Mode

- **Role:** Student
- **Goal:** Examine the selected anatomical model without automatic explanations
- **Benefit:** Enable focused review and instructor led explanation when needed
- **Priority:** Must-have
- **Acceptance Criteria:**
    o **AC1:** Review Mode can be accessed from the main menu or from within the module flow as defined by the application design.
    o **AC2:** In Review Mode, only the selected anatomical model assets are displayed for manipulation.

- o **AC3:** In Review Mode, the system does not display information cards or automatic explanatory text.

US-S10- Basic Comfort and Audio Settings

- **Role:** Student
- **Goal:** Adjust basic settings to use the application comfortably
- **Benefit:** Better usability and comfort during VR sessions
- **Priority:** Should-have
- **Acceptance Criteria:**
  - o **AC1:** A settings menu is accessible from the main menu.
  - o **AC2:** Changes made in the settings take effect within the same session.

5.2. Instructor User Stories

US-I01- Running a Demo Flow in Class

- **Role:** Instructor
- **Goal:** Guide students during VR Anatomy sessions without interacting with the VR application directly
- **Benefit:** Ensure a safe, structured, and curriculum aligned learning flow in classroom or laboratory use
- **Priority:** Should-have
- **Acceptance Criteria:**
  - o **AC1:** The application supports individual single headset sessions, allowing a student to use VR while the instructor guides the activity externally.
  - o **AC2:** The application provides a clear and predictable flow that can be followed without instructor interaction, including a visible main menu and a straightforward way for the student to start the learning experience.

6. Scope Boundaries

6.1. In Scope

Within the scope of this project, an initial version of a VR supported anatomy learning application will be developed. The goal of this initial version is to provide students with a clearer learning experience by enabling interactive, three dimensional exploration of anatomical content in a VR environment. The initial version includes the following capabilities:

- **Module based structure and flow:** When the application starts, the student selects an anatomy module from the main menu in VR. The content of the selected module is loaded and becomes available. In the initial release, the module set may be limited based on content production capacity.

- **3D visualization and exploration:** Anatomical models are displayed in VR and can be examined from different viewpoints through standard exploration controls.
- **Basic VR interactions:** Students can interact with the content using VR controllers, including selecting structures and examining supported parts through grabbing, rotating, and releasing.
- **Highlighting and information delivery:** When a structure is selected, the system visually highlights the selection and displays the structure name and a short, level appropriate information card. The information card can be closed by the student.
- **Review Mode:** A Review Mode is provided where only the assets of the selected anatomical model are displayed for free examine. In this mode, the system does not show information cards or automatic explanatory text, allowing instructor guided explanation when needed.
- **Quiz Mode:** Quiz Mode can be accessed directly from the main menu and can be used independently from module exploration. Multiple choice questions are presented on a VR panel, and the system provides immediate correct or incorrect feedback after an answer is submitted.
- **AI Tutor Chat:** The system provides question and answer support through an AI Tutor Chat interface that opens when the module is selected. Answers are generated based on the project provided learning content and are displayed within VR in a readable format. If relevant content is not available, the system returns a clear fallback message rather than guessing.
- **Basic UI and settings:** Core navigation and interface actions are included, such as returning to the main menu, switching modules, opening and closing panels, and basic comfort or audio settings.
- **Offline-capable core experience:** The core learning experience runs using locally packaged content. If the AI Tutor service is unavailable, the AI chat feature is disabled or unavailable while the rest of the application remains usable.

6.2. Out of Scope

The following items are out of scope for the initial version of the project:

- **Broad anatomy coverage**: Full coverage of the entire human body and advanced level detail across all systems is not targeted. Content will remain limited and manageable based on production capacity.

- **Clinical and diagnostic use**: The application is not designed for diagnosis, treatment guidance, clinical decision support, or processing patient related data.

- **Advanced medical simulation and procedure training**: Features such as surgical simulation, medical procedure training, pathology and disease scenarios, and advanced haptic feedback are not included.

- **Multi user VR experience**: Multiplayer sessions, shared virtual classrooms, avatar based collaboration, and real time multi user interaction are not supported.
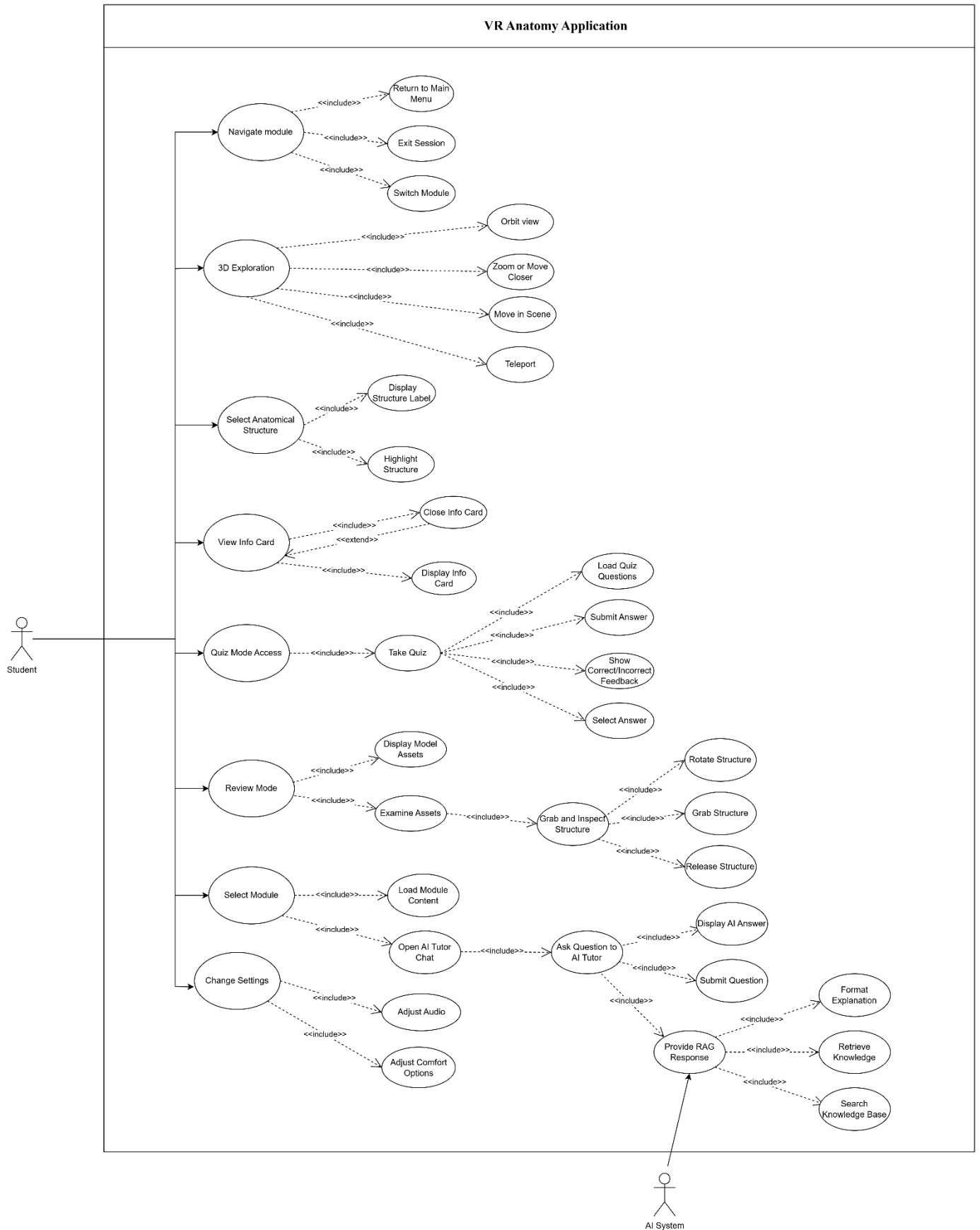
- **Accounts and long term analytics:** User accounts, authentication, role based access control, persistent progress tracking across sessions, detailed assessment reports, and long term learning analytics are not included.

- **Instructor specific interface and in app content authoring**: A separate instructor interface and tools that allow adding or editing content during runtime are not included in the initial version.

- **Guaranteed AI accuracy and availability**: The AI Tutor feature does not provide guarantees of correctness under all conditions and may be affected by connectivity or external service availability. When the AI service is unavailable, the core application features remain usable.

6.3. Future Work

After the initial version, the product may be expanded depending on time, resources, and feedback gathered during use. Possible future improvements may include:

- **Content expansion:** Additional anatomical systems and a wider set of structures may be added in a modular manner to increase curriculum coverage.

- **Enriching the learning experience:** The quiz section may be expanded with more varied questions, optional mini activities, and a more structured progression to support step by step learning.

- **AI Tutor improvements:** If infrastructure allows, retrieval quality may be improved through better indexing and content organization. The system may also provide references to the learning material used to form answers, support multiple explanation levels, and optionally enable voice based question and answer.

- **Visual quality and performance:** 3D assets may be further optimized, performance tuning and level of detail improvements may be applied, optional lightweight animations may be added, and additional comfort settings could be included.

7. Use Case Model

8. Conclusion

The VR Anatomy project presents a focused and deliverable initial version designed to support introductory anatomy learning through an immersive and interactive 3D VR experience. The application provides a clear navigation flow, basic VR interactions for exploring anatomical models, and structure focused learning support through highlighting, labels, and short information cards. Learning is also reinforced through a dedicated Quiz Mode that enables quick self assessment with immediate feedback.

The report defines clear scope boundaries to keep the project feasible under constraints such as budget, time, content production capacity, and VR performance requirements. Broad anatomy coverage, clinical or diagnostic use, advanced medical simulations, multi user VR scenarios, persistent accounts and long term analytics, and in application content authoring tools are excluded from scope. The AI Tutor Chat, when available, provides educational explanations based on the project provided learning content without offering medical advice. Finally, the user stories and acceptance criteria provide measurable targets to guide implementation, testing, and evaluation in classroom or laboratory contexts.