HI BC
Helping IMGs
in British Columbia

CENTRE FOR DIGITAL MEDIA

UBC SFU emily carr university of art + design BCIT

Project Documentation

Team HI-BC

CDM C15 SPRING 2021

Team Members:

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Cornelia Lai, Heesu Kim

Faculty Advisor:

Robyn Sussel

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1. Project Overview

1.1. The Team

Product Designer	Gareun (Karen) Lee
UX Lead	Emma Liu
UI Lead	Cornelia Lai
Dev Lead/ Project Manager	Daniel Tian
Dev Second Lead	Hee Su Kim

1.2. Background

The University of British Columbia Faculty of Medicine, Division of Continuing Professional Development (CPD), is a team of medical education professionals whose mission is to research, develop, implement, and evaluate continuing professional development initiatives for physicians and other health professionals to optimize clinical practice and the delivery of patient care to improve health outcomes.

In partnership with the Practice Ready Assessment British Columbia (PRA-BC), CPD hosts a nine-day orientation of a recertification program for medical doctors trained outside of Canada, called IMGs (International Medical Graduates). The Sensitive Exams Refresher Course is a half-day component of the Orientation, which familiarizes IMGs with appropriate ways to conduct breast and urogenital exams in the Canadian Medical Context. Preparing IMGs to perform these exams confidently in Canada is even more critical because they will be on the frontline of preventive care in the underserved rural areas in British Columbia for at least three years as part of the recertification program.

1.3. Purpose

Due to the Covid-19 pandemic, CPD had to transition from in-person sessions to online learning. Before the pandemic, clinical teaching associates (CTAs) trained to lead students on how to perform sensitive exams acted as mock patients to teach the maneuvers and communication skills to IMGs in Vancouver General Hospital rooms during the Orientation. CPD faces a challenge to deliver the same high-quality education and training despite the restraint the pandemic has imposed.

Live streaming CTA-lead mock sensitive exams as they would happen offline before the pandemic can be extremely problematic. CPD is currently not equipped with an audio-visual integrated room and CTA cannot make sure IMGs are watching what they intend them to watch on Zoom. Furthermore, the nature of the exam where CTAs have to take their clothes off before the camera and reveal their body parts creates hosts of privacy issues and can make them feel more uncomfortable and less safe compared to a tightly controlled offline setting.

Due to these concerns and CTA unavailability during the pandemic, CPD did not choose the live-

stream option but instead used Zoom breakout rooms for IMGs to do the role play with each other verbally. In order to get around the apparent limitation of Zoom, CPD encouraged the IMGs to verbalize their thinking in a format of 'I am going to do…(action) because…(rationale)' to observe their clinical thinking process.

1.4. Goal and Objectives

For IMGs who need to learn and practice communication skills in the context of the Canadian medical and cultural context, the Team HI-BC (a team of four graduate students from the Centre for Digital Media (CDM) and one visiting UBC student, 'the Team' hereafter) aims to build a Proof of Concept (PoC) of a simulation platform that enables IMGs to do one on one real-time role-play with an instructor or a peer. The Team will focus on replicating a breast exam situation using 3D avatars in a virtual clinic-like setting. Unlike video chat platforms like Zoom that IMGs are currently using to do the role-play, the PoC will provide an immersive environment where they can refine their conversational skills while going through procedures such as washing hands or making contact with a patient virtually. The enactment via avatars provides a rehearsal opportunity for IMGs to 'act out' rather than talk through the role-play as they would during the live, in-person course before Covid-19. Moreover, an avatar adds an extra layer of comfort and security to the person who plays a mock patient's role.

2. Scope & Constraints

The purpose of the PoC is to test and prove the basic mechanics of the IMG training simulation platform for a breast exam with a focus on communication skills. It does not seek to replicate exact maneuvers or tactile feel of them. The Team will use all reasonable endeavours to make the PoC look and function in a realistic and immersive way within the 13-week timeframe and budgetary constraints. The project duration corresponds with the spring semester of CDM, which lasts from January 11, 2021, to April 16, 2021. Some components or actions desirable for the virtual role-play may not be fully implemented depending on the availability of the 3d assets & animations and the number of hours they require to execute.

The PoC will be a stand-alone digital product that is not bound by the technical specifications of the Learning Management System (LMS) CPD is currently using. It will only work on laptop or desktop with Window installed on it. It is not a web-based solution, and the user must install exe files to run it on their computer. Also, it is not responsive and can be best viewed on a laptop or desktop with a resolution of 1920 * 1080.

3. Deliverables

Proof of Concept

- Real-time Multiplayer Simulation Platform
- Voice chat feature between Role Players
- Character Animations Necessary for a Breast Exam Role-Play
- Mood Bar and Emojis to Express a Mock Patient's Emotional States
- Backend Data Collection for Future AI-powered Virtual Patient Creation
- A Doctor's Office (Typical Family Practice Setting)
- Two Doctor Characters and Attire (Male/Female)
- Two Patient Characters and Attire (Male/Female)
- Onboarding Feature for New Users (Doctor/Patient)
- Documentation

*A server should be set up by CPD before the Orientation in April to enable multiple pairs of IMG and CTA can use the platform simultaneously.

4. Research

4.1. Users & Stakeholders

4.1.1. User Persona & Journey Map

The primary end-user of the PoC will be IMGs. The secondary user can be CTAs or Canadian family physicians, depending on their availability during the Orientation. We didn't have a chance to interview IMGs directly, but we collected data through other research methods such as reading IMGs interviews or asking about IMGs to subject matter experts who have extensive experiences with them.

IMG Persona

Mike Burnett

Age 45, 20 years physician in Egypt

Hospital:

EI Fardous Hospital

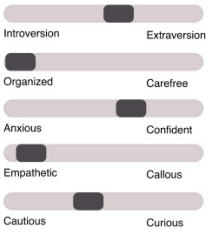
Location:

Cairo

Title:

Attending Physician

Big 5 Personality Profile:



Description

Mike is a 45-year-old physician who has been working in the medical field in his country for the past 20 years. He wants to immigrate to Canada with his family and change his career path to the Canadian healthcare industry. As an international medical graduate, he has to participate in a sensitive exam course in Canada and integrate into the BC healthcare system.

Goals

> Adapt to a different approach to practice medicine.
> Across different cultural contexts within healthcare internationally.
> Use appropriate communication language with patients in sensitive exams in the Canadian medical context.
> Settle down in Canada with his family.

Journey

> Mike watchs YouTube tutorials and online courses to have a better understanding of the medical working environment in west countries.
> Due to the Covid-19 pandemic, all the in person lecture and didactic content have been translated to online learning. Mike tries his best to practice communication skills with the patient through simulation Zoom sessions.

Pain Points

> While the training has been translated to online learning, Mike no longer has access to the standardized patient and clinical skills programing that would afford him the opportunity to learn and practice the exam maneuves and communication skills associated with sensitive exams in the context of the Canadian medical system.
> Due to the differences in cultural background and religion, Mike has not performed any sensitive exam in routine practice in his country.

For more details:
https://drive.google.com/file/d/1RcZHUAekmYI4kXbZtM-LWkhwobDOnPLF/view?usp=sharing

CTA Persona

Connie Lee

Age 50, 25 years clinical teaching assistant in Canada

Institution:

PRA-BC

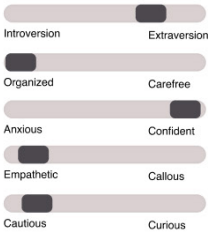
Location:

Vancouver

Title:

Clinical Assistant Professor

Big 5 Personality Profile:



Description

Connie is a 50-year-old clinical assistant professor who has been working in the medical field in Canada for the past 25 years. She wants to help international medical graduates integrate into medical practice across BC. As a clinical teaching assistant, she has to help IMGs participate in a sensitive exam course in Canada and integrate into the BC healthcare system.

Goals

> Help IMGs adapt to a different approach to practice medicine.
> Help IMGs across different cultural contexts within healthcare internationally.
> Correct inappropriate communication language and behaviours with patients in sensitive exams in the Canadian medical context.
> Support IMGs settle down in Canada with their family.

Journey

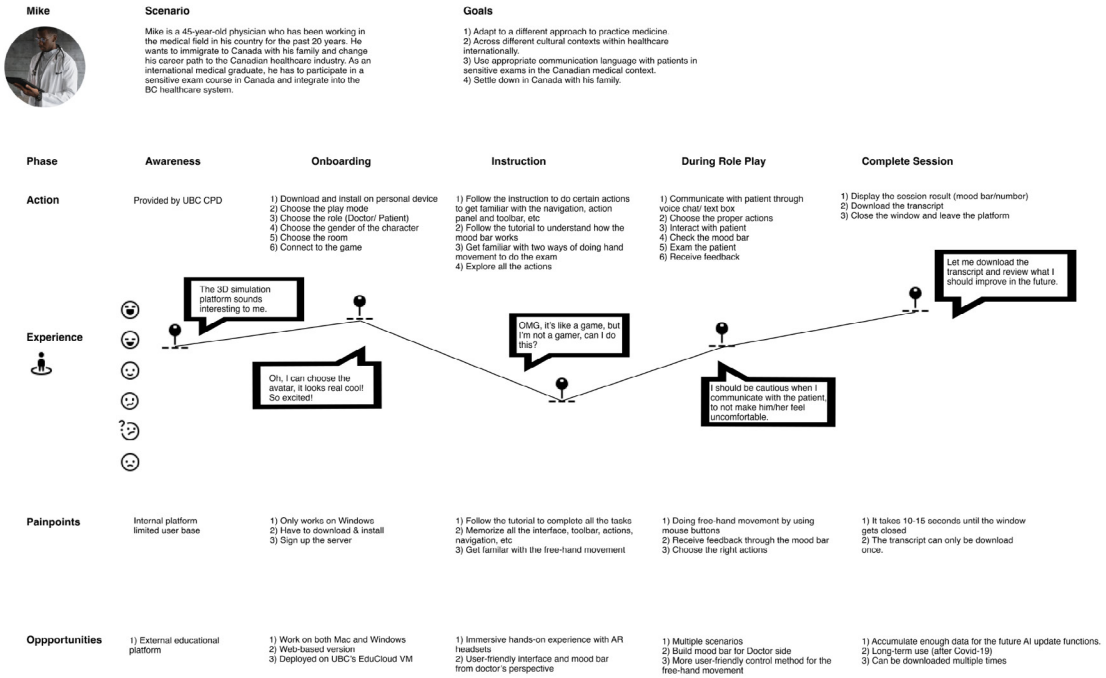
> Connie has regular sessions with IMGs and communication around sensitive exams. Usually, she walks through the steps of the exams to let IMGs have a better understanding of the medical working environment in Canada and provide instant feedback.
> Due to the Covid-19 pandemic, all the in person lecture and didactic content have been translated to online learning. Connie tries her best to help IMGs practice communication skills in the context of Canadian medical system through simulation Zoom sessions.

Pain Points

> While the training has been translated to online learning, Connie can not provide the in-person hands-on experiential teaching experience to the IMGs as before the Covid-19.
> Due to the differences in cultural background and religion, Connie has to correct the inappropriate communication and behaviours that IMGs may have performed for many years.

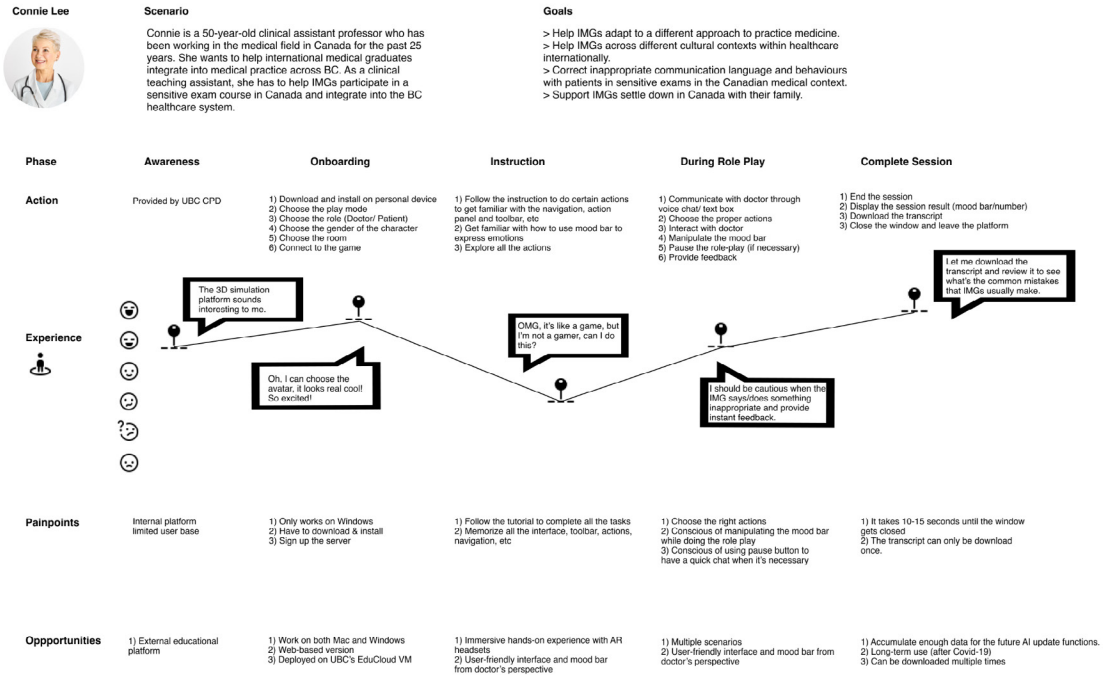
For more details:
https://drive.google.com/file/d/1ufn_zSR7BIvs2UrfvLwxND7jUxQdIkWh/view?usp=sharing

User Journey Map (IMG)



For more details:
https://drive.google.com/file/d/1GCmYiPHho7TMdDJYWm-b3NAiG0O0D5m2/view?usp=sharing

User Journey Map (CTA)



For more details:
https://drive.google.com/file/d/1MKQEmeEWn603VLDXtq9zfcAKCHCREXRp/view?usp=sharing

4.1.2. Stakeholders

UBC CPD

CPD will meet with the Team regularly to discuss the direction of the project and give feedback on the Team's progress. It will do its best to arrange meetings with as many medical professionals as possible so that the Team can conduct user testing necessary for each design & development phase.

PRA-BC

PRA-BC is responsible for the administration of the entire recertification program. UBC CPD will mediate any project-related communication with PRA-BC.

Team HI-BC

The HI-BC Team will do the design and development of the PoC.

Faculty Advisor

The advisor will do the advisory role for the project and evaluate each team member's performance.

CDM

The CDM is the counterpart of CPD in formulating a contract of the project. It will be responsible for the transfer of Intellectual Property of the final deliverables and other administrative details on the project.

4.2. SWOT Analysis

4.2.1. Realtime vs. Non-Real Time

The Team presented 5 concepts to CPD with its respective pros and cons on January 27, 2021. After careful review, the Team and CPD collaboratively decided that the number 1 option was the best path to pursue for the project. Non-VR Real-time role-play provides quality feedback and educational experience compared to Non-Realtime options. Also, the collected backend data can be used to build a more realistic virtual patient (instructor) in the future. Considering that VR option requires a gaming PC and other equipment, it adds logistical/budgetary burden to CPD. Since the focus of the refresher course is communication skills not clinical skills, VR is too expensive to be an effective solution for the project.

Realtime

Live human interaction that does not confine CPD to a specific, fixed scenario

- **Non-VR** (web-based)
  - 1 — 3D Avatar Role Play (1-on-1 between IMG & Instructor)
  - 2 — Lecture + Discussion format multiplayer virtual space with majority vote feature
- **VR**
  - 3 — 3D Avatar Role Play Powered by Motion Capture (participate and/or observe)

Image Source -1. https://acadicus.com/simulation-environments/ 2. https://www.standardpatient.org/spsplayer/player.php 3. https://www.tomshardware.com/news/high-fidelity-vive-tracker-mocap,35164.

Non-Realtime

Interaction with Virtual Patient

- 4 — **Role Play**

  IMG ⇄ Bot

  - Text-Based
    - Multiple Choice
    - Type
  - Voice Command
- 5 — **Game Play**

  Check whether IMGs can detect (in)appropriate behaviors through a game play

4.2.2. Respective Pros & Cons

Options	Pros	Cons
Non-VR 3D Avatar Role Play with an instructor	• Live 1 on 1 interaction between instructor & IMG • Real-life like improvisions possible • No need to come up with fixed, detailed scenarios • Compared to VR, faster, easier to develop and test (relatively)	• Can only happen 1 on 1, need similar number of instructors as that of IMGs unless others just observe • IMGs cannot access it after the orientation
Non-VR Lecture + Discussion	• Live interaction between Dr.Chang & IMGs and among IMGs • Promote Discussions • Easy visualization & sharing of cohort's decisions • Compared to VR, faster, easier to develop and test (relatively)	• Slow & Lengthy Process (discussion & voting) • Little procedural rehearsal • Cannot explore other scenarios not adopted by the majority • One-on-one feedback/after orientation access are not available
Realtime VR	• Realtime exact movement tracking • The most accurate online replication of offline human interaction • The most Immersive	• Costs & Logistics of equipment (headset + hand controller + gaming laptop) • Higher chances of technical glitches • Requires a high-end computer on both ends • Cumbersome on users

Role Play Non-VR 3D Avatar Role Play with a BOT	• 1 on 1 feedback is available for each IMG although limited in scope • Scalability • Constant improvement possible based on Analytics Data • Stepping stone for a more advanced future AI version	• Heavy burden on CPD: writing each permutations of the scenarios and appropriate feedback • Harder to keep up with updated scenarios
Game Play	• Accessible regardless of time & space • Scalability • Constant improvement possible based on Analytics Data • Can be fun and engaging	• Heavy burden on CPD: writing each permutations of the scenarios • Harder to keep up with updated scenarios • Little procedural rehearsal

4.3. Comparative Advantages

CPD needs a simulation platform that focuses on training IMGs to communicate confidently with patients. The platform should also accommodate the pandemic situation where IMGs have to access it remotely from a hotel in Vancouver during the Orientation. However, most medical simulation solutions on the market focus on a procedural rehearsal for surgery or emergency response and require a VR headset or other equipment. In contrast, the HI-BC team's platform can be accessed without any equipment and will be tailored to promote communication skills in a real-life like sensitive exam context. Synchronous, authentic interaction with an instructor on the platform can enhance the educational experience compared to fixed scenario-based, computer-generated feedback. The PoC will also record the live interaction in a text format so that CPD can feed the data to Artificial Intelligence to build a virtual patient in the future and provide customized educational experiences without adding burden to instructors. The list of major medical simulation solutions on the market will be provided as a separate file.

5. Key Design Decisions & Rationale

5.1. Navigation

Initially, the avatars were designed to freely move around in the 3D space like most role-playing games using 'WASD' keys on the keyboard. Based on the results of 2 rounds of user testing with Dr. Yau and CTAs, one round of CDM peer user testing and faculty feedback, the Team has made changes. Dr.Yau and 3 CTAs had difficulty navigating the space using keyboard shortcuts. They expressed their wish to be teleported rather than manually moving around. Since communication is the main focus of using the platform, spending time and effort on communication makes more sense than trying to familiarize themselves with navigation. Thus, only the 'AD' key for the users to rotate the view and no 'WS' key from both the navigation panel and tutorial. The entire role-play is possible using teleporting rather than manually moving around by using the keyboard.

5.2 Camera (Third Person/ Partial First Person)

The Team designed our camera with a third-person view combined with a partial first-person view. During the role-play, mostly it will be third-person, only the first-person view for examining action from the doctor side. Interviews with CTA revealed that the role-play between CTAs and IMGs is not like immersive RPG games. Rather, they go in and out of immersion for the CTA to give immediate feedback on the IMG's actions. It is more about doing the action while trying to objectify oneself, so a third person was a better fit for the purpose. But the third-person camera created unnecessary steps like turning view for the doctor's examining action, so the Team made only the examining action first-person. The first-person perspective can also provide an immersive experience for the doctor to focus on the examination hand maneuver.

5.3. Control (Hand Movement)

The Team designed the free-hand movement to allow the users to simulate the breast exam. Based on the CDM peer user testing result and faculty feedback, the Team added a more straightforward movement to perform the exam by clicking the 'H' key on the keyboard. Free-hand movement using mouse buttons is more difficult compared to clicking buttons. However, some users still preferred to use this option because it made them feel they are doing the actual exam, especially during the outlining, where the doctor touches a broader area other than the breast to signal to the patient where the breast tissues are located and prevent any misunderstanding. One CTA preferred simpler movement because mouse control was too cumbersome. However, the Team didn't have direct access to IMGs for user testing, and the data was incomplete and too little for us to decide on the hand movement during the examination. So, the Team chose to provide both options and remind the options to users during the role-play so that CPD can have an opportunity to see which method IMGs find more useful and make necessary changes accordingly in the future.

5.4. Action Button (Undress Options)

The Team designed the action buttons to enable our users to perform a series of actions during the role-play. A preliminary list of actions was based on the Stanford Medicine educational video and confirmed and refined by Dr. Yau and CTAs from the user testing. As a doctor, you can ask the patient to undress and go out of the room to give her privacy. You can come back inside the room, wash your hands and start examining. As a patient, you can sit or lie down on the exam table. You can raise your arm/arms, touch the tender area, or change clothes, etc. The Team learned from the user testing that exposing only the minimal required part of the patient's body is an important part of the training. Therefore, the Team decided to offer 5 different options for 'Undress' Action. The patient can choose to change normal clothes to a gown, expose each side of the breasts, or completely remove the gown if necessary.

6. Technical Specifications

6.1. Overview

The HIBC simulation platform uses the following tech stacks: C#, Unity Engine, SQLite database and EduCloud. The 3D assets were developed using 3rd party tools including Character Creator 3 and Blender.

All the pre-existing assets and codes can be found on this GitHub repository:
https://github.com/kessris/UBC-CPD-Breast-Exam-Simulator

The following sections will include all necessary specifications required to set-up and further develop the platform.

6.2. Project Setup & API endpoints

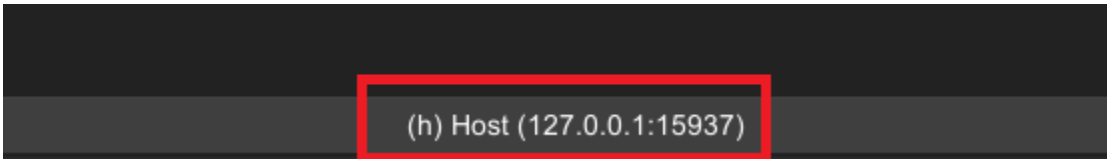
6.2.1. Running the Platform

Server-side

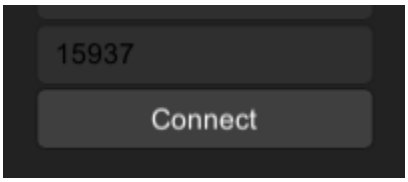
A server must be running in order to allow people to join the role-playing room. To allow anyone to join at any time, the server is deployed to a cloud VM (EduCloud). Note that if the server-side application crashes for some reason (i.e., internet reconnection, power outage, etc.), someone must log on to the VM instance and restart the application.

To allow other users to join, port forwarding must be enabled for Port 15936 (used as Room1) and 15937 (used as Room2). Port forwarding is automatically set-up on the VM so nothing needs to be done, but in case of emergencies, someone may need to run the server on their local computer. In such a case, they must go to their appropriate service provider's address from a browser to configure their router settings. The steps differ for each service provider but a step-by-step guide can be easily found on Google most of the time.

The server-side application looks very similar to the client-side application, except that it has a hosting button instead of the pre-selection screens. Clicking on the button that looks like a bar at the bottom will start the server. Note that the character that joins from the server side cannot be seen by anyone else that joins.

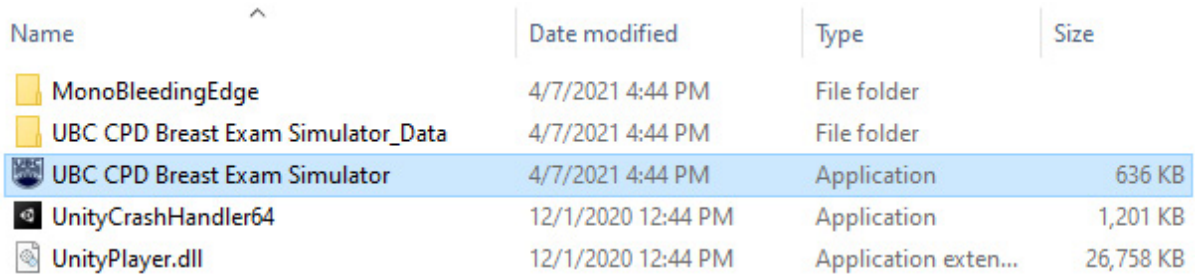


There needs to be two programs running on two different ports, which are used as two different role-playing rooms. Thus, one application must start with Port 15936 by editing the second field, right above the 'Connect' button, then clicking the Host button at the bottom. Similarly, another application must be open with 15937 entered in the second field and clicking Host.

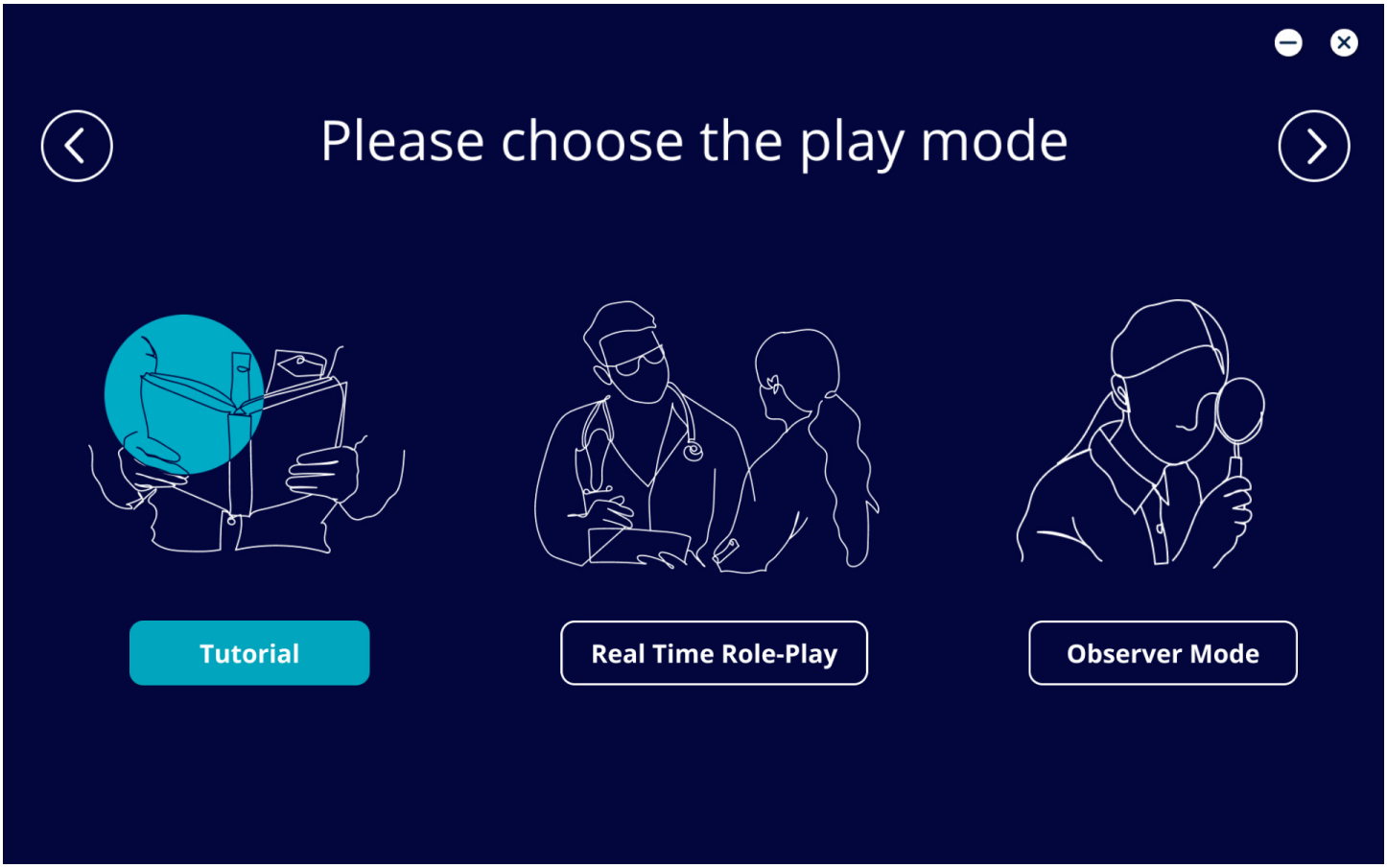


Client-side

IMGs and CTAs must each download their appropriate files (Doctor or Patient). To run the program, they must double-click on 'UBC CPD Breast Exam Simulator' and allow any firewall pop ups.



Once they enter the platform, they will be given three options to choose from: Tutorial, Real Time Role-Play and Observer Mode.



Tutorial mode provides the user with an interactive tutorial to introduce all the buttons and capabilities within the platform.

Real Time Role-Play will give choices of entering Room1 or Room 2. This option is available in case two role-play sessions must be held simultaneously. In such case, each pair must decide in advance which room to meet in.

Observer mode allows a user to join any of the role-playing sessions as an invisible observer. It is intended to provide an educational experience to other IMGs by allowing them to participate in their peer's role-playing sessions. Once an observer enters a room, all users inside the room will be notified that an invisible observer has entered their room.

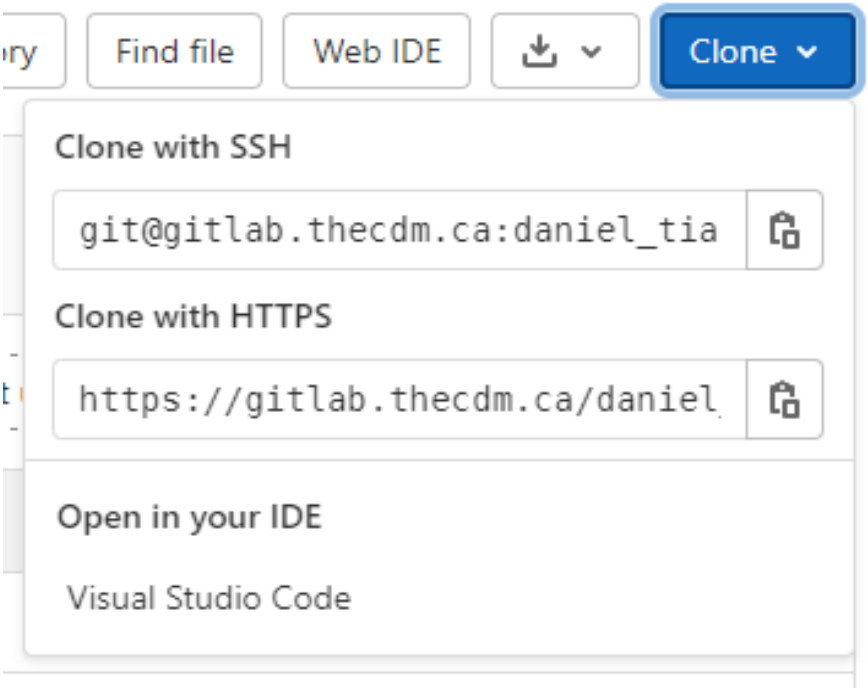
6.2.2. Development Environment Set Up

This section assumes you have the correct environment set-up with the following:

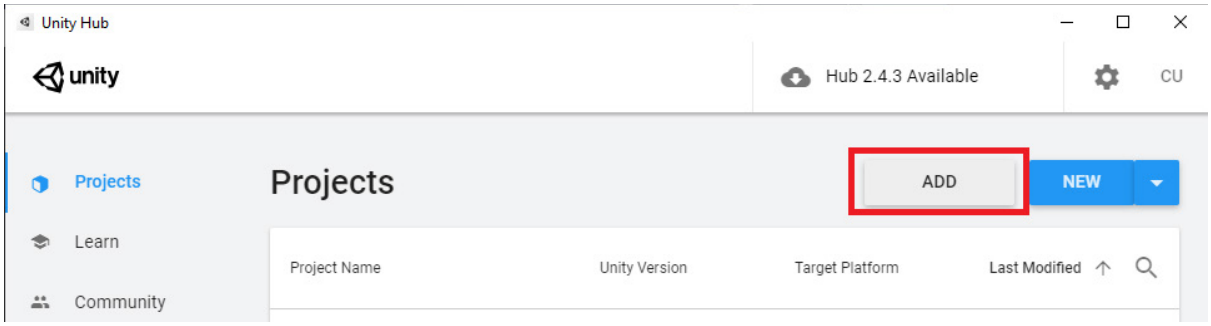
Unity (Version 2020.1.17f1) : https://unity3d.com/get-unity/download/archive
Visual Studio or any IDE of your choice for C#
PC running on Windows OS

Clone the Git repository (link in the previous section) / Or alternatively extract the provided zipped asset files (project.zip)

1. Open the cloned repository from Unity Hub. Note that it might take some time to load the project for the first time.



2. Open the cloned repository from Unity Hub. Note that it might take some time to load the project for the first time.

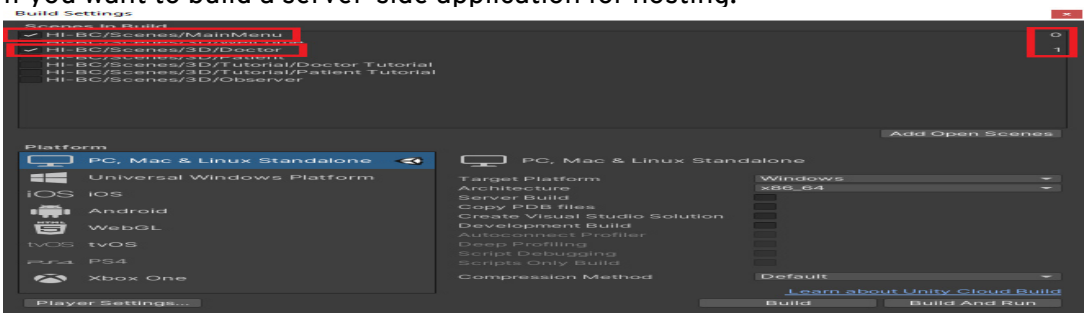


6.2.3. Building the Project

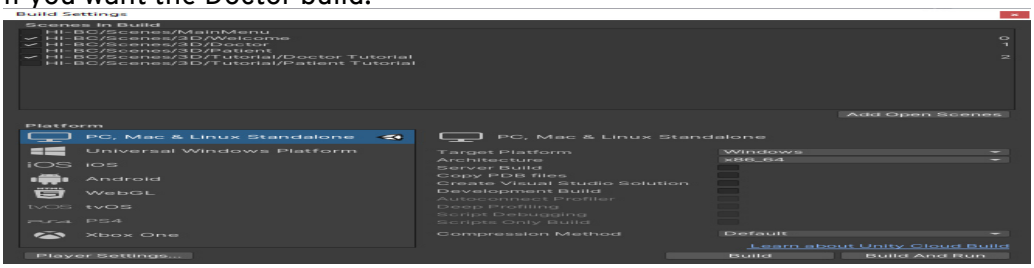
1. Go to 'File' > 'Build Settings...'
2. Check all the scenes you would like to build with. Note that the order of the scenes matter.
3. Click 'Build' at the bottom right corner and select a folder you would like the build to be in.

Examples:

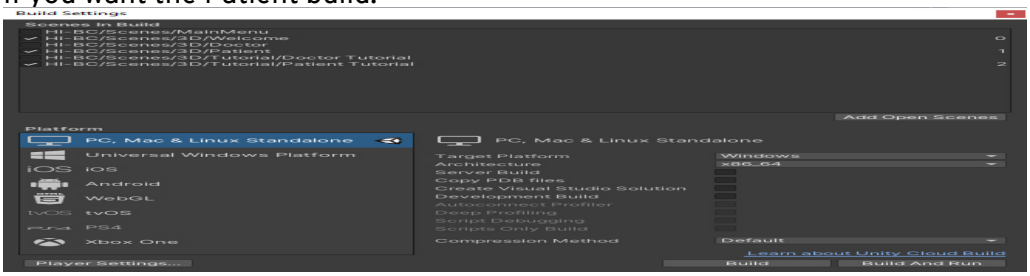
If you want to build a server-side application for hosting:



If you want the Doctor build:



If you want the Patient build:



6.2.4. Google Speech-to-Text API

You can log onto Google Cloud Console (https://console.cloud.google.com/) using the following credentials:

Username: ubc.cdm@gmail.com
Password: 2021UBCCDM
Recovery email: Deborah.w@ubc.ca

You can see the usage report and manage billing from the link above.

The Speech-to-Text API is called from a script called 'StreamingRecognizer'. Inside a scene (i.e., Scenes > 3D > Doctor), you will find a 'Chat' prefab with this script attached. If you want to disable the API, simply deactivate the script from the Chat prefab.

To associate a specific Google account with this API, you need to replace the JSON key file inside Assets > StreamingAssets. The details are on this website: https://cjames1.medium.com/how-to-add-google-speech-to-text-in-unity-2019-61c4920c4145

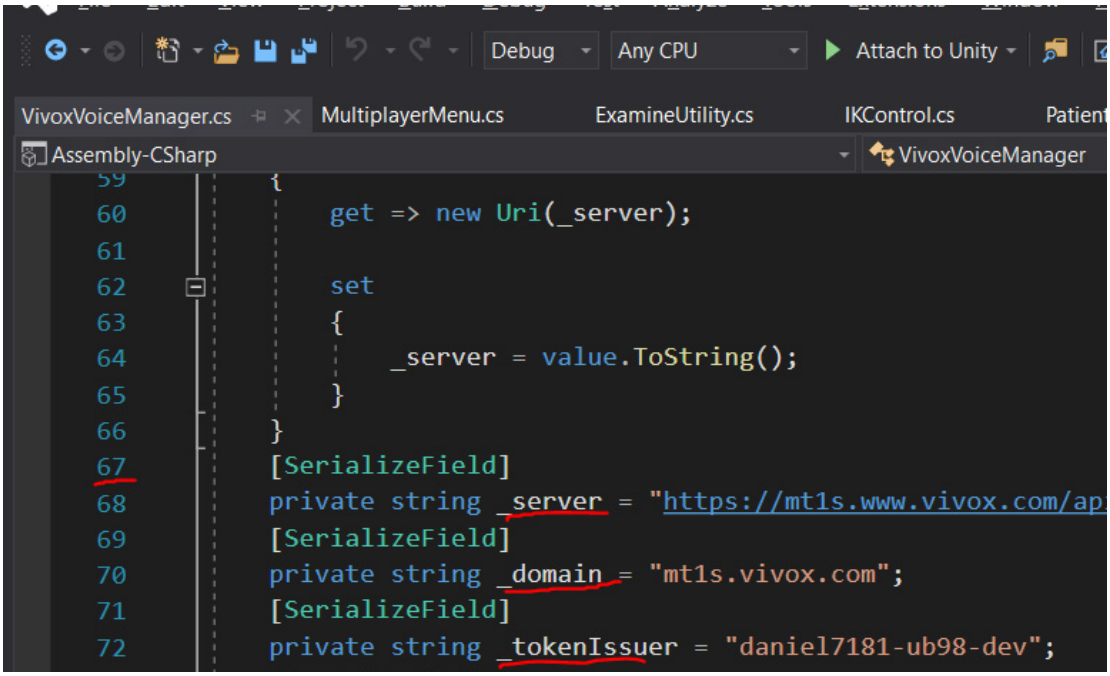
6.2.5. Vivox Voice

Vivox voice chat is a high quality voice api used by many popular games around the world, such as Fortnite. Unity recently acquired Vivox, and offers it to be used for free as long as there are less than 50 active users. More information can be found at https://developer.vivox.com/

Vivox voice chat is the voice api used for this project. Details regarding how to manage and replace the link with your own account should the need arise will be outlined in the Vivox section below. The website can be accessed at https://developer.vivox.com/ using the following credentials:

Username: daniel_tian2002@hotmail.com
Password: vivalavivox2

In order to change the API endpoint for Vivox voice chat in the future, simply go to the script in the folder: Assets/HI-BC/Scripts/VivoxVoiceManager.cs and change the following 4 fields (starting from line 67) to your own domain and token should the need ever arise. where to edit the vivox server credentials (underlined in red)

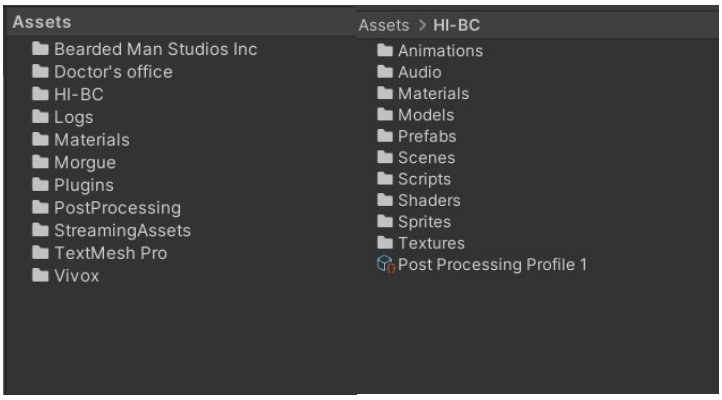


6.3. Assets

6.3.1. Unity File Structure

Our project was made in Unity, so it follows a fairly standard file structure commonly found in most Unity projects. All of the folders except HI-BC are simply external asset folders, with only the HI-BC folder containing the majority of our source code. I have highlighted some of the more important folders below

Bearded Man Studios Inc - This is the folder containing all of the networking api code from Forge Networking. Within there are automatically generated classes for synchronizing doctor and patient position, animation and chat.
Doctor's office - This folder contains assets such as the clinic room 3d model as well as everything within it like furniture, potted plants, the exam table, sink, and so on.
HI-BC - The folder that contains all of our source code. We have named the subfolders within HI-BC in a way that follows unity conventions (Scripts contains raw C# code, models contains the 3d models, prefabs contains prefabs that we've put together to be used in our scenes, and so on).



6.3.2. Characters

There are four 3D characters being used for this platform. Male doctor, female doctor, male patient and female patient. These 3D models can be found under 'Assets' > 'HI-BC' > 'Prefabs' > 'PlayerPrefabs'.

These characters are instantiated when they join a room. The models are registered as Player Network Object inside a prefab called 'NetworkManager' (Assets > Bearded Man Studios Inc > Prefabs). The code that instantiates the models is inside the script 'GameLogic.cs'.

6.3.3. Scenes

The active scenes that are being used for the platform are:

Scenes > 3D > Doctor
Scenes > 3D > Patient
Scenes > 3D > Welcome
Scenes > 3D > Tutorial > Doctor Tutorial
Scenes > 3D > Tutorial > Patient Tutorial

6.4. Backend

6.4.1. Networking

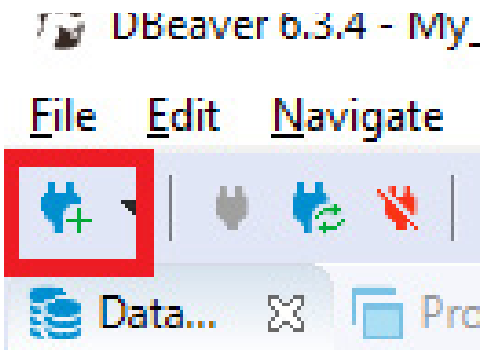
The networking solution the Team have chosen for the project is Forge Networking. The source code, as well as documentation, can all be found here: https://github.com/BeardedManStudios/ForgeNetworkingRemastered

Forge Networking is a completely free and open source multiplayer networking system that has complete integration with the Unity Game Engine, which makes using it a breeze. There are editor scripts and UI tools built right into the tool (which can be opened by pressing ctrl+g or going to Window -> forge networking -> network contact wizard). This allows for developers to extend the library as they wish. The benefits of using forge networking is that it saves a lot of time that would have been wasted reinventing the wheel via writing the networking layer for our solution. Forge provides easy methods of synchronizing game objects and game state in Unity via their position, rotation, and any other arbitrary data which can all be updated via RPC (remote procedural call) methods.

6.4.2. Data Collection

Conversation data is recorded inside SQLite database on the server side. This includes any conversation recorded by Speech-to-Text API and chat box, as well as moodbar clicks and patient actions The script that records these data are written inside 'ChatManager.cs' in Assets > Bearded Man Studios Inc > Modules > Chat > ChatManager.cs.

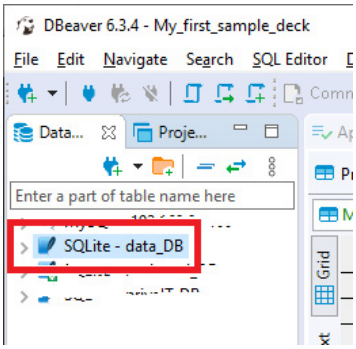
To view the database, it is recommended to download DBeaver, a free database application: https://dbeaver.io/download/. After you open the application, click on this icon at the top left corner.



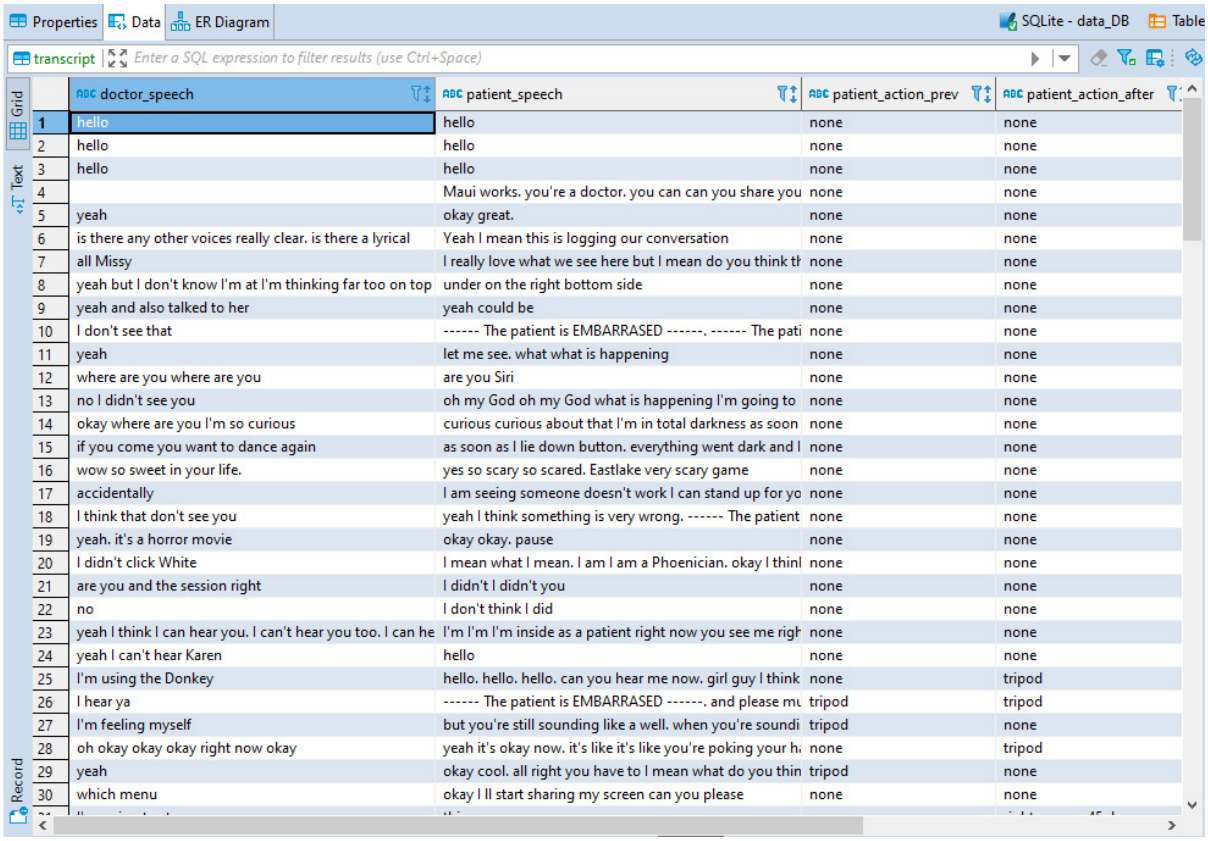
Select ‘SQLite’, click ‘Next’, then click ‘Browse…’.

The database file (‘data_DB’) will be located either in ‘%userprofile%\AppData\Local\Packages\<productname>\LocalState’ or ‘%userprofile%\AppData\LocalLow\<companyname>\<productname>’. Find the file called ‘data_DB’ from one of these paths and click ‘Open’. Click ‘Finish’.’

Now you will be able to open the database.



Expand the icon above, go to ‘Tables’, and double-click on ‘transcript’. You will see all the conversation data that’s been stored after each role-play.



Properties | Data | ER Diagram — SQLite - data_DB — Table

transcript | Enter a SQL expression to filter results (use Ctrl+Space)

	doctor_speech	patient_speech	patient_action_prev	patient_action_after
1	hello	hello	none	none
2	hello	hello	none	none
3	hello	hello	none	none
4		Maui works. you're a doctor. you can can you share you	none	none
5	yeah	okay great.	none	none
6	is there any other voices really clear. is there a lyrical	Yeah I mean this is logging our conversation	none	none
7	all Missy	I really love what we see here but I mean do you think th	none	none
8	yeah but I don't know I'm at I'm thinking far too on top	under on the right bottom side	none	none
9	yeah and also talked to her	yeah could be	none	none
10	I don't see that	------ The patient is EMBARRASED ------. ------ The pati	none	none
11	yeah	let me see. what what is happening	none	none
12	where are you where are you	are you Siri	none	none
13	no I didn't see you	oh my God oh my God what is happening I'm going to	none	none
14	okay where are you I'm so curious	curious curious about that I'm in total darkness as soon	none	none
15	if you come you want to dance again	as soon as I lie down button. everything went dark and I	none	none
16	wow so sweet in your life.	yes so scary so scared. Eastlake very scary game	none	none
17	accidentally	I am seeing someone doesn't work I can stand up for yo	none	none
18	I think that don't see you	yeah I think something is very wrong. ------ The patient	none	none
19	yeah. it's a horror movie	okay okay. pause	none	none
20	I didn't click White	I mean what I mean. I am I am a Phoenician. okay I thinl	none	none
21	are you and the session right	I didn't I didn't you	none	none
22	no	I don't think I did	none	none
23	yeah I think I can hear you. I can't hear you too. I can he	I'm I'm I'm inside as a patient right now you see me righ	none	none
24	yeah I can't hear Karen	hello	none	none
25	I'm using the Donkey	hello. hello. hello. can you hear me now. girl guy I think	none	tripod
26	I hear ya	------ The patient is EMBARRASED ------. and please mu	tripod	tripod
27	I'm feeling myself	but you're still sounding like a well. when you're soundi	tripod	none
28	oh okay okay okay right now okay	yeah it's okay now. it's like it's like you're poking your h	none	tripod
29	yeah	okay cool. all right you have to I mean what do you thin	tripod	none
30	which menu	okay I ll start sharing my screen can you please	none	none

6.5. 3D Modelling and Animation

6.5.1. Pipeline

For creation of 3D assets, several 3rd party programs and a plugin were used, including Character Creator 3, Blender and Auto Rig Pro. Character Creator 3 was purchased by UBC CPD and thus, using this software should work with the following license:

The user name is: CDMUBC
The account password is: CDMubc2021
The email address: pra.orientation@ubc.ca

Blender is free to download here: https://www.blender.org/download/

Auto Rig Pro Plugin can be download here: https://blendermarket.com/products/auto-rig-pro

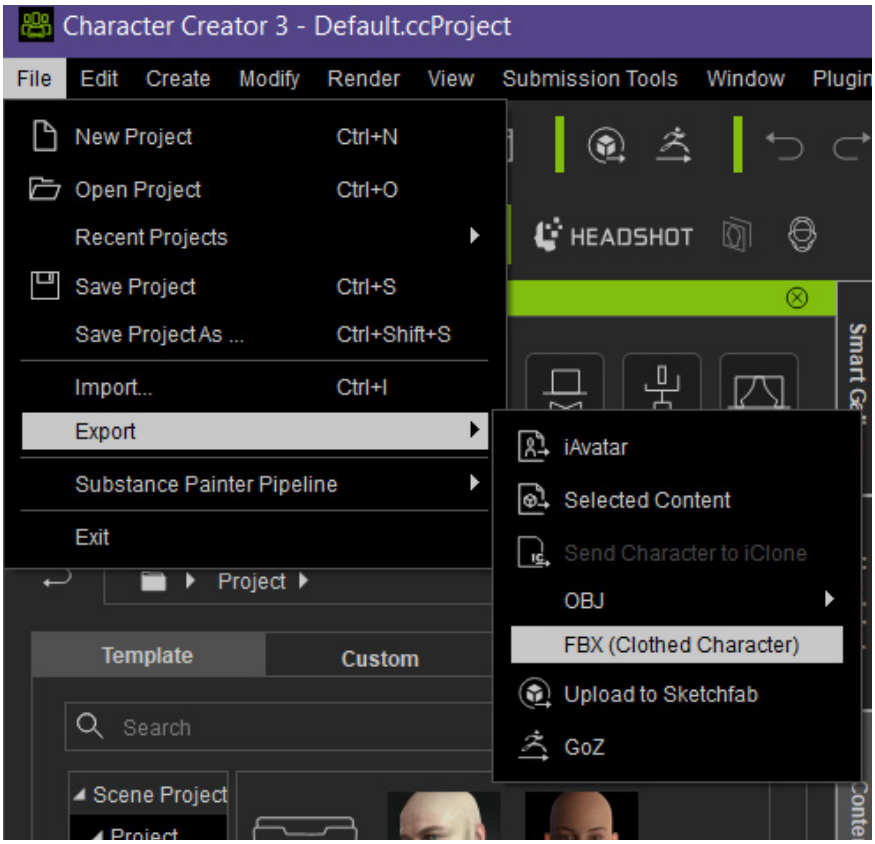
Name: UBC CPD
Username: cdmubcc
PW: CDMubc2021

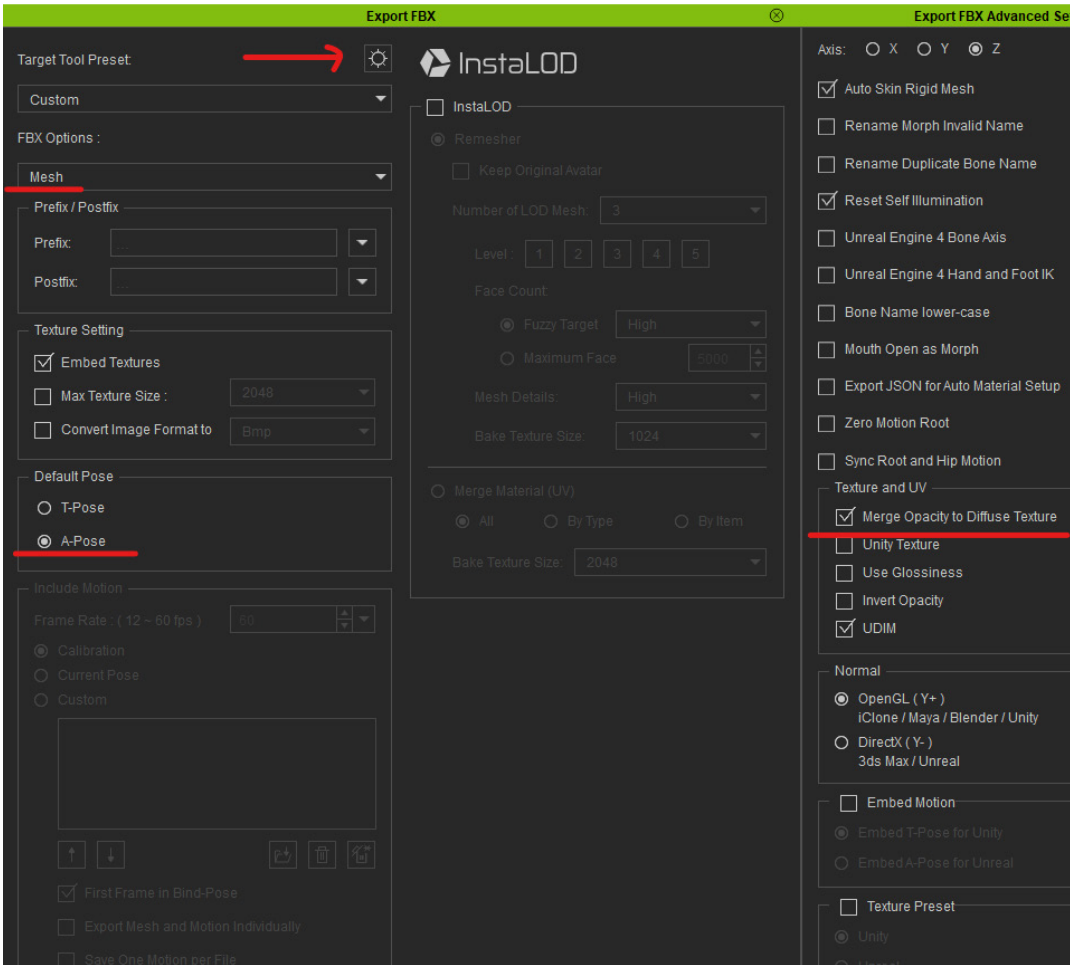
6.5.2. Character Creation

4 characters were created as shown below. 2 of them are Doctors and the other 2 are Patients.

6.5.3. Exporting to Blender

File > Export > FBX (Clothed Character) > Target Tool preset : Blender
> FBX Option: Mesh > Make sure A - Pose is Checked
> Clip on the “Sun” like button > Check Merge Opacity to diffuse





6.5.4. Rigging

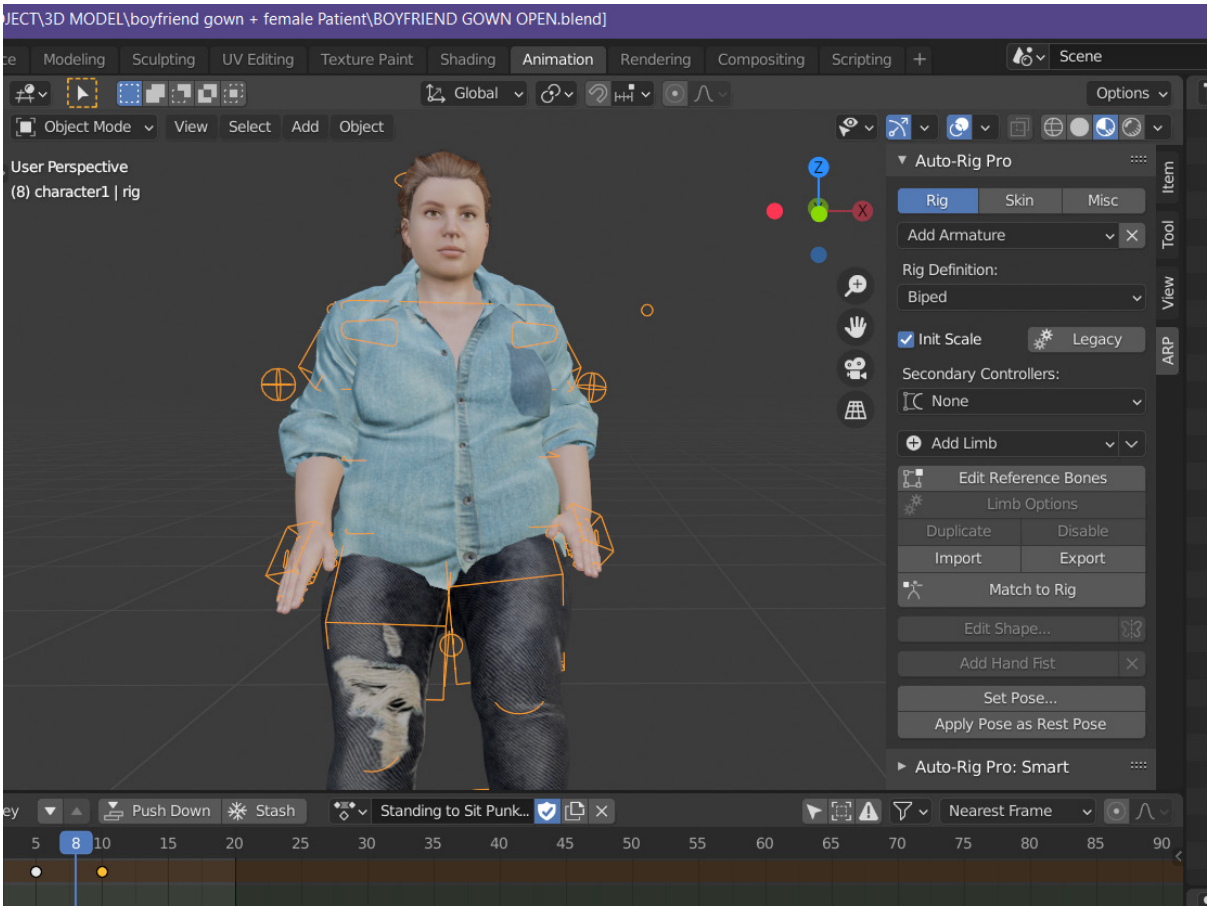
Character Creator 3 avatars do have pre-existing rigging attached to the body mesh. However, in order to use Blender to customize the animation, there are some fixes needed inside Blender using the plugin called

Auto Rig Pro. The tutorial is attached to the link https://www.youtube.com/watch?v=1fsM5IuFQbI

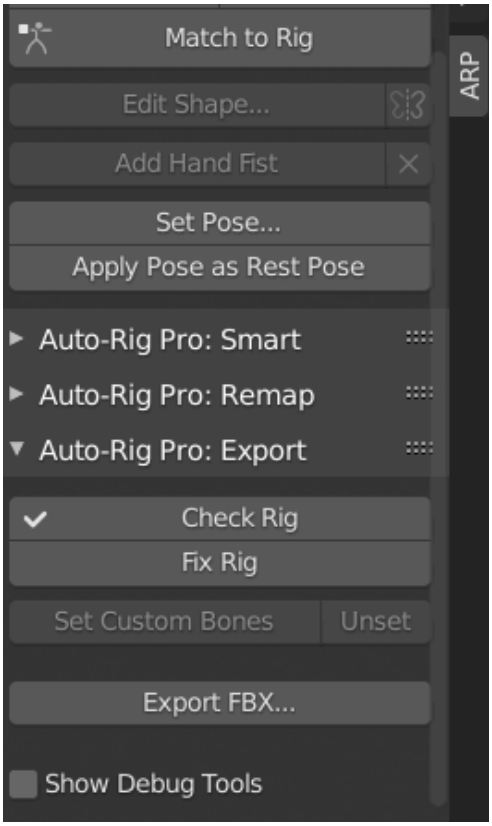
6.5.5. Character Animation

The exported character file (*.fbx) from Character Creator 3 was imported to Blender for custom animation. The characters were rigged and adjusted using Auto Rig Pro. Then animate the character inside Blender. The animated characters are needed to be exported as *.fbx again, but using the plugin (Auto Rig Pro) to make sure it contains humanoid functions for Unity.

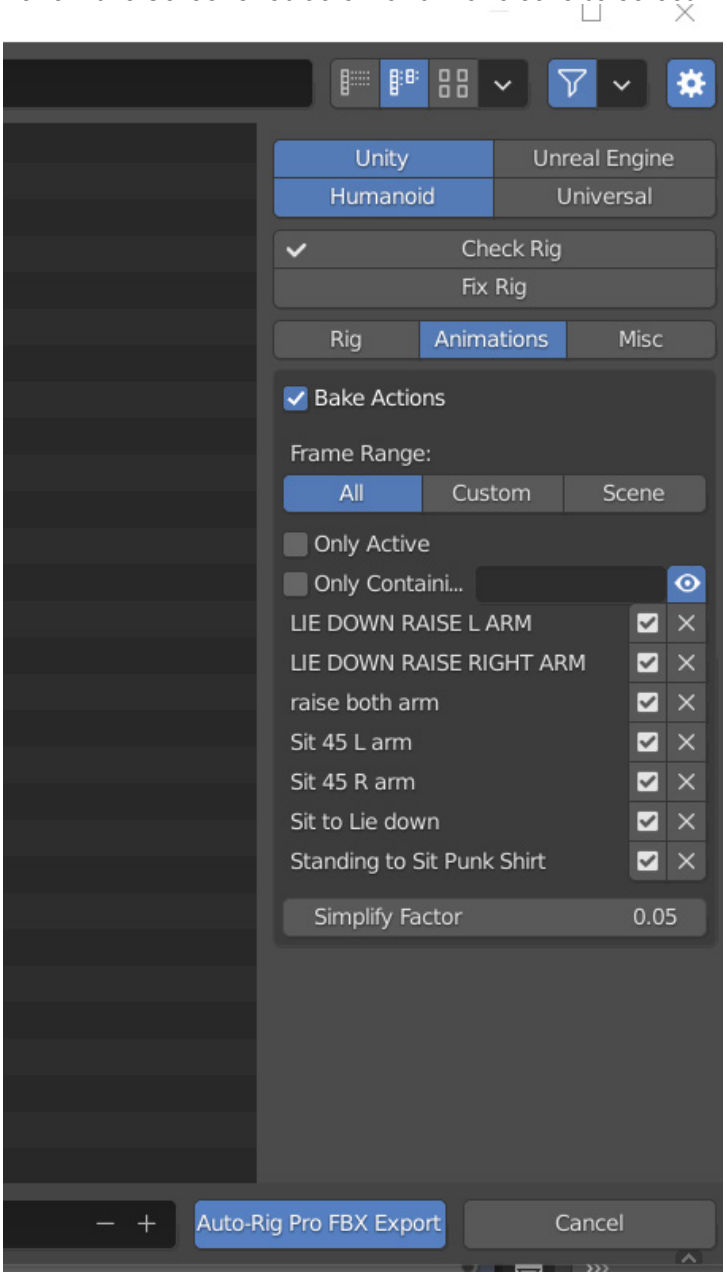
1. Make sure Rig is selected (Highlighted in Orageng)



2. Go to Auto Rig Pro Panel > Select Rig > scroll down and click Export



3. Follow the Screenshot below and make sure to select Humanoid > Auto Rig Pro FBX Export



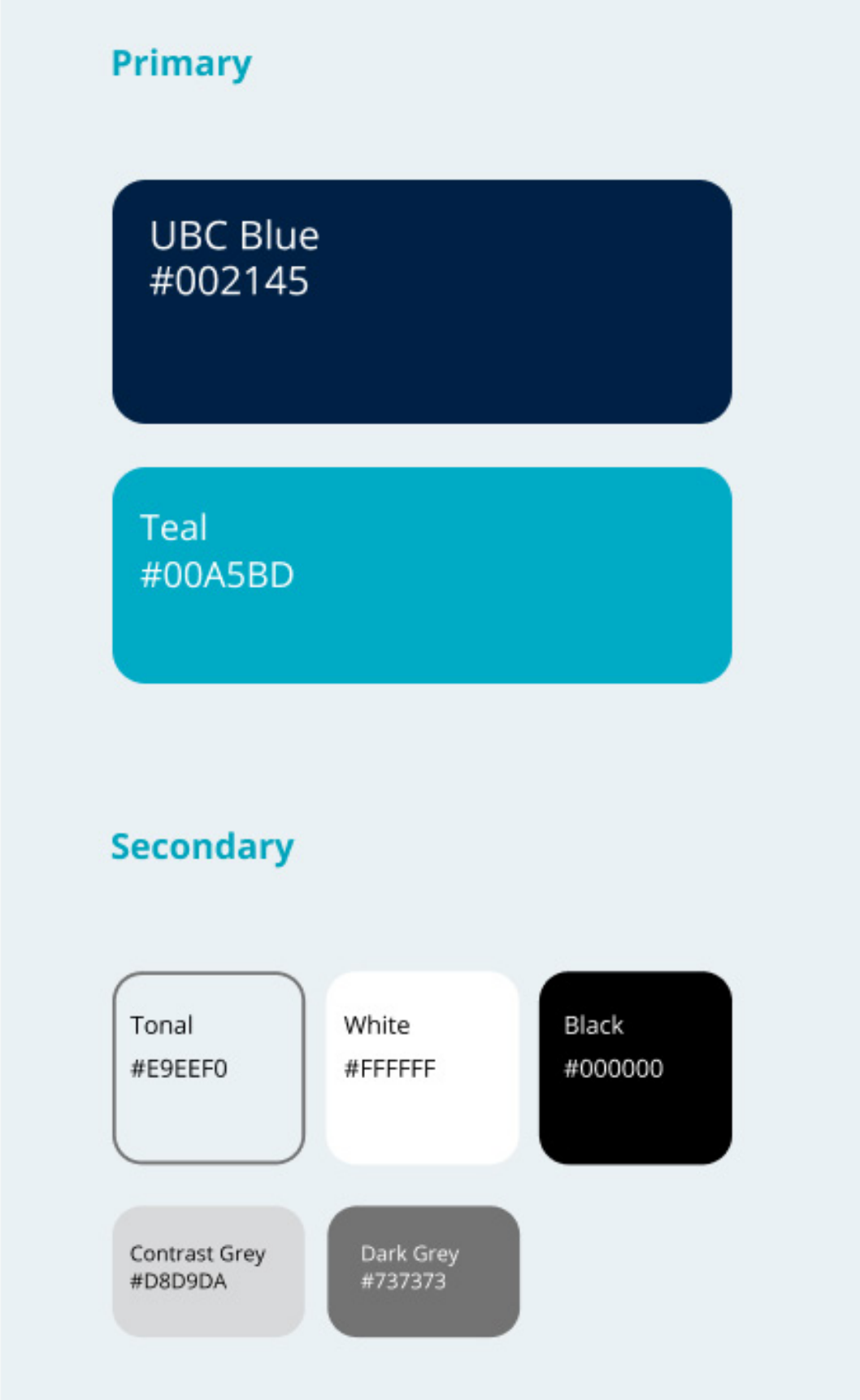
6.5.6. Importing Characters to Unity

The exported *.fbx file from Blender can be imported into Unity. All the layers (i.e., hair, clothing) will persist, so that you can easily take off character's clothing within Unity. Similarly, each components such as rigs and animation can be extracted separately from the *.fbx file.

7. Style Guide & Design System

A Style guide was created in line with UBC CPD's brand guideline to allow team and client insight into the intended visual style and overall appearance of the product

Colors



Typography

Open Sans

Aa Aa

Bold Regular

Display (Bold 64 px)

Title 1 (Bold 36px)

Title 2 (Bold 24 px)

Body 1 (Regular 24 px)

Title 3 (Bold 20 px)

Body 2 (Regular 18 px)

Emphasise Body 2 (Bold 18 px)

Caption (Caption 16 px)

Color

Primary Color

Use a primary color for main titles and body text.

TEXT TEXT

Dark Background: White #FFFFFF
Light Background: Black #000000

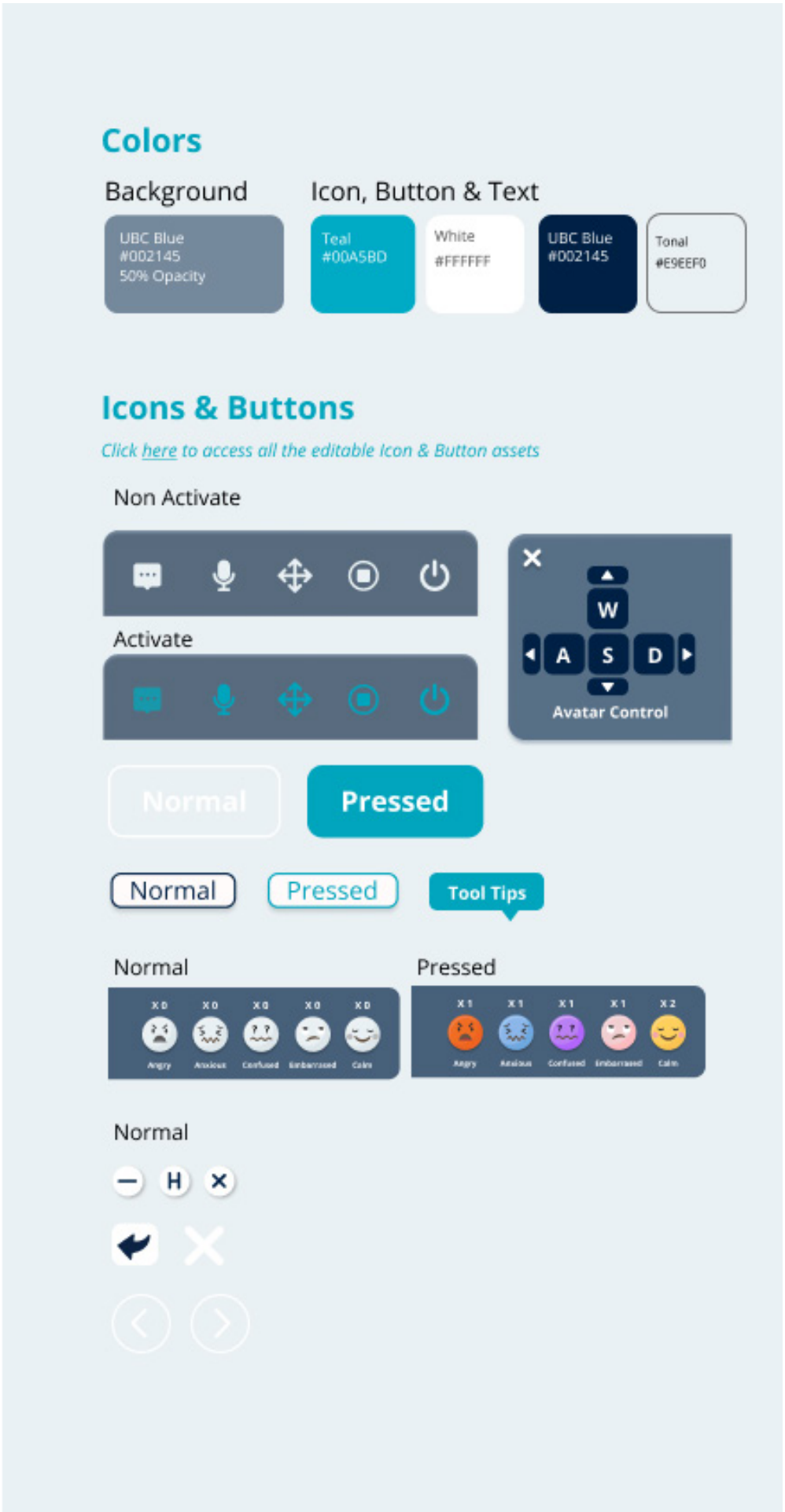
Secondary Color

Use a primary color for main titles and body text.

TEXT TEXT

Dark Background: Contrast Grey #D8D9DA
Light Background: Dark Grey #737373

Icons & Buttons

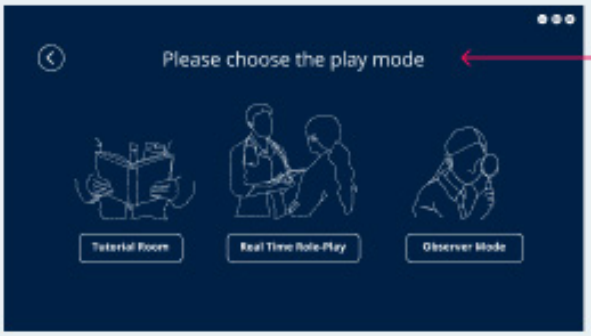


Typography

Usage

Display

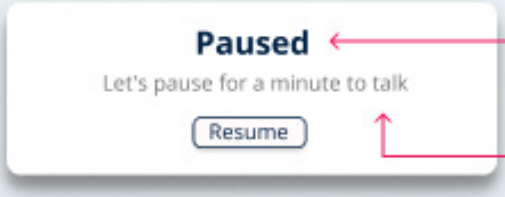
Use display style for delivering primary messages and Titles



Display
Open Sans Regular
64 px

Title

Use title style to summarize content that follows the title. Carefully pairing title with body to makes content hierarchy obvious and improves readability.



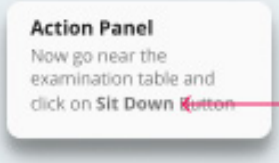
Title 1
Open Sans Bold
36 px

Body 1
Open Sans Regular
24 px

Title 3
Open Sans Bold
20 px

Emphasis

Use emphasized style on body text that needs to stand out from regular content.



Emphasis Body 2
Open Sans Bold
18 px

Typography

Line Length

The number of characters per line influences readability. Studies indicate the following guidelines for English:

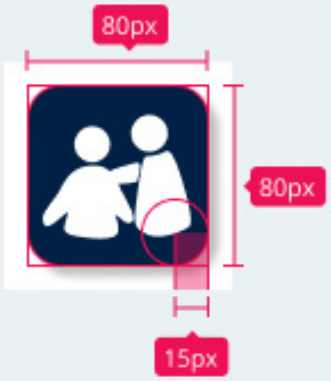
- *Satisfactory*
  45-75 characters (desktop) per line is widely regarded as a satisfactory line length.

- *Optimal*
  Around 66 characters (desktop) is optimal.

- *Too long*
  More than 90 characters (desktop) is likely too long for continuous reading.

Icons & Buttons

Button Construction

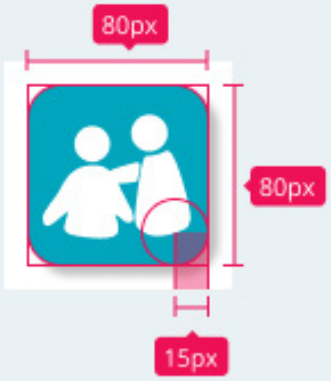


Toggle Button Defualt

Drop shadow
x: 4 y: 4 Blur: 4
Color: #000000
Opacity: 25%

UBC Blue #002145

White #FFFFFF



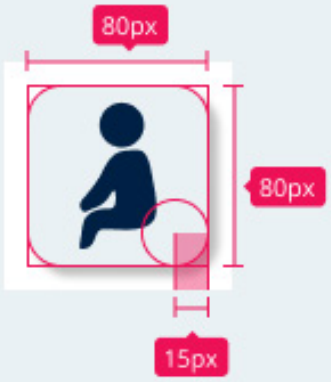
Toggle Button Pressed

Drop shadow
x: 4 y: 4 Blur: 4
Color: #000000
Opacity: 0%

Teal #00A5BD

White #FFFFFF

Icons & Buttons

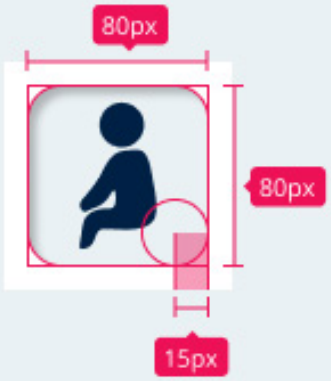


Normal Button Defualt

Inner shadow
x: 4 y: 4 Blur: 4
Color: #000000
Opacity: 25%

Tonal
#E9EEF0

UBC Blue
#002145



Normal Button Pressed

Inner shadow
x: 4 y: 4 Blur: 4
Color: #000000
Opacity: 25%

Drop shadow
x: 4 y: 4 Blur: 4
Color: #000000
Opacity: 0%

**Apply 0% Opacity Drop shadow to aline the size of Pressed Indent Button with the Normal Defualt Button*

Tonal
#E9EEF0

UBC Blue
#002145

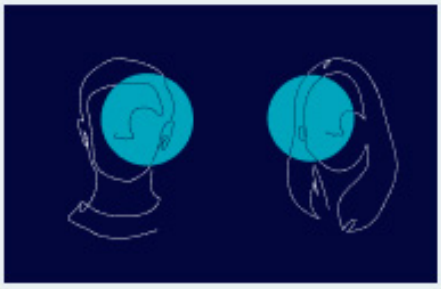
Illustration

The illustration style follows the UBC CPD Brand Guidelines, Please see details on P62-69 of CPD Brand Guidelines.

The illustrations are semi-continuous line drawings that give a hand-drawn and grounded quality.

Illustrations of human interactions and activities are all drawn with a connected line. This is an illustration style that evokes connection in both form and function.

Illustrations can have a spotlight overlay by making a copy of the illustration and pasting it into a circle. Applying inverted spotlights on the illustration will highlight the topic that the illustration depicts and add a bolder dynamic to the light and airy layouts, pulling the eye to it as a central focus.



Refer to these relative spotlight sizes when creating your own illustrations. The spotlight diameter is roughly 1/2 to 1/3 of the height or width of the illustration.

8. Challenges & Takeaway

Only the lead dev of the team had a past experience developing 3D multiplayer games, and none of the members had experience working on healthcare projects before. The following are the major challenges we had to deal with in the process:

8.1. Unpredictable User Testing Schedule

Availability of medical professionals for input was the biggest challenge of the project. Whether and when the Team can have direct access to IMGs and CTAs for interview and user testing was not clear until week7. Furthermore, the testing sessions were spread across multiple days as opposed to a typical one day 5-6 participants user testing schedule. The Team adapted by building testable 2D prototype (v2) early on as fast as possible so that they can take the testing opportunities whenever that would be. Due to unpredictability of schedule, the sprint goal had to be changed in the middle of the sprint once and sprint duration had to be changed a few times, which is normally not desirable, but it was inevitable under the circumstances. The Team remained t rue to the spirit of the Agile Responding to change over following a plan rather than the Scrum framework.

8.2. Multiple Instances of Simultaneous Role-Play with Single Hosting

Currently the program uses Forge Networking to spin up the server to allow multiple users to join the platform. During the development phase, it was done by hosting the server on one of the team members' local computer to create one instance of the clinic room. However, the team thought it was essential to allow at least two role-playing sessions to be held simultaneously for two pairs in different clinic rooms. The solution was to host two different instances on two ports, 15936 and 15937. Anyone who chooses Room 1 from the welcome screen will enter the clinic room set up on Port 15936 on the server machine, and anyone who chooses Room 2 will enter the clinic room on Port 15937.

Furthermore, it was necessary to allow users to use the platform whenever they desired, but it was problematic with the method of hosting the server on someone's local computer. For instance, the server would close whenever the computer went to sleep or was turned off. To solve this problem, the team ultimately decided to host the server on a Virtual Machine on cloud. This would also allow anyone with access rights to easily log onto the VM instance from anywhere at any time to spin up the server again in case of trouble. Multiple testings were conducted using AWS and Google Cloud VMs, and all went successfully. After discussion with the client, the platform was finally deployed on UBC's EduCloud VM .

8.3. Unexpected Technical Difficulties

Creating a 3D space and animated characters that can be manipulated real-time by multiplayers involves a lot more uncertainty and unexpected technical difficulties than standard web or app development.

8.3.1. Combining Doctor/Patient Build

We planned on combining the doctor and patient builds during the planning phase, but ran into time constraint issues as the project progressed. It was difficult to combine the two scenes into one (which sounds simple on paper), because the patient and doctor had different user interfaces and different scripts set up in their respective scenes. We also had our networking scripts tied into this problem, because on network startup the patient/doctor's initialization code included finding scene Gameobjects with certain names and with specific network scripts attached on them. Initially we tried to simply switch out the player prefab, but keep the same scene, but found out that without dedicating a significant amount of dev time, we couldn't implement this change without creating a new script to rearrange and delete features from the shared scene, which would introduce more problems when we wanted to add features to a doctor/or patient's respective scenes. In the end, we scrapped this idea.

8.3.2. Going back to the Home Screen during/after the role-play

Initially, the platform included a Home button which would allow the users to go back to the initial Welcome page. When this idea came up, the team did not foresee any difficulties and thought it would be a simple implementation. However, unexpected issues arose; it was much more difficult than the team thought to clean up the network objects after leaving a server, then rejoining fresh on some server again. After multiple attempts to fix the networking issues for days, the team agreed that the home button is not a critical feature and is an icing to have. Thus, the ticket was put back into the backlog and the focus shifted to implementing other essential features. As of now, the users must close and re-open the program to join another room or to start a real-time roleplay after the tutorial.

8.3.3. Synchronizing the Status of All Players

All player states are synchronized over the network via the ForgeNetworking API, a free open source networking api for game development. The underlying network code is written in C#, which makes it easy to extend its functionality (since it's a high level programming language that's easy and familiar to most developers) to suit our needs. All players location (a Vector3 value, which is just a x,y,z location in digital numerical values), rotation (Quaternion), as well as the actions that they take such as raising hands or expressing emojis are synchronized with remote procedural calls - which works simply by the client sending a packet (for example: raise left arm) to the server, at which time the server will broadcast this information to all other connected clients (at which time, usually after 0.1-0.2 seconds everyone else will see the client raise their left arm - to humans this appears to be real time).

One problem we ran into was synchronizing the state of players already connected to the server to players that have joined afterwards. Due to the constraints of time, we hadn't considered that players that join after

will be viewing the default animation of connected clients, which is not the actual state of the players on the server. The way we've implemented synchronizing the animation is that only when a player clicks on an action button (such as raising the left arm), we send that as a remote procedure call to all other connected clients. For clients that connect afterwards, they won't be able to see that a patient has raised their left arm. However, if the patient raises their right arm, then the connected client will be able to see that. Overwriting the onplayerconnected functions within Forgenetworking, and to write a simple function that would broadcast the animation states of all existing players to players that have just joined could be a solution.

8.3.4. Custom 3D modeling & Animation

The team designed the patient avatars to be slightly overweight to represent the North American standard patient population. Clothing for patients is also intentionally designed to represent the rural area. The doctor avatars represent the IMGs demographic, who are in their 50s and wearing smart-casual outfits in the clinic. The team custom-made the look of the patient's gown to fit the sensitive exam scenario. Due to the breast exam nature, patients should be wearing a medical gown and only expose necessary body parts when needed. But because the gown and the animation need to be made inside Blender and then imported into Unity, some unexpected technical difficulties happened because of the compatibility issues. The team consulted 3d design experts and researched online to solve most of the issues. However, due to time constraints, some problems such as hair texture and clothing simulation remain. The Pipeline of Creating a customized avatar in Character Creator 3, Import into Blender for animation and finally import again into Unity to build the product is challenging. But the team tried hard to solve the most prioritized problem to make the function of the product working successfully.

9. Future Considerations

Some of the features that are desirable but could not be implemented due to the scope and constraints of the project. We have listed them below in the order of priority.

9.1. Accessibility Enhancement

It is possible to make the PoC work on Mac OS or web as well, but it requires more time to build and test. Web version will certainly increase the usability because users do not need to download anything, but making a multiplayer game with multiple simultaneous role-play working on the web presents quite a bit of challenge. Although it is possible to build it so that it can be used on a smartphone, given the objective and context of the usage, it is questionable whether it adds value. However, a tablet version of the PoC could increase the usability of the product without hurting the immersion because tablet devices offer tactile user interface. Touching the avatar to examine the patient is much more intuitive and easy compared to mouse button click or drag.

9.2. Other Sensitive Exams

Since the PoC is a platform that enables multiple pairs of users to do a real-time role-play, CPD can choose to add other sensitive exams such as a pap test, or rectal exams.

The following will be the most efficient steps of adding another exam to the platform:

10.2.1. Set up an one hour meeting with at least 5 CTAs. It would be most efficient to set up the meeting all on the same date if possible
10.2.2. Ask them to do a role play for the test as they normally do with an IMG.
10.2.3. Ask them what are the most important points IMGs should be mindful of or common mistakes in the context of the exam
10.2.4. From the observation and information given by them, distill the most essential set of actions and equipment and confirm those with Dr.Yau.
10.2.5. Purchase or build necessary 3D assets and animations and integrate them to the platform
10.2.6. Test MVP with IMGs & CTA and keep improving on the key features.

9.3. Virtual Patient

Current natural language processing technology is not good enough to mimic human interactions yet. Furthermore, Google Speech to Text API has difficulty recognizing speech with thick accents. Also, it takes considerable time and a large number of IMG-CTA pairs to do the role-play to collect enough back-end data to build a meaningful virtual patient. Most important factor in building a virtual patient that would react in a way human instructors would is collecting a large amount of quality data, which takes time. In the meantime, CPD can experiment with building a hard-coded scenario based virtual patient by manually gleaning information from the back-end data. It is feasible to build a virtual patient with basic communication skills like this USC example using Google Assistant SDK.

9.4. Various Characters with Hyper-Realistic Visual

Hyper realistic visuals and various characters that better reflect real IMGs' demographic could increase immersion. Also, a variety of patient characters that reflect myriads of different physical traits and sexual orientations of patients can better prepare IMGs for a real-life situation. However, it requires many professional 3D artists and animators to custom make hyper-realistic visuals and smooth animations for each character, so a cost benefit analysis is required to go forward with the option.