KENDŌ GAKKŌ

剣道学校

DESIGN DOCUMENT

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Section 1.0

Design Document

1.1 Project Overview

Kendō Gakkō (Kendo School) is a mixed platform experience where users can learn about basic Kendo techniques, learn basic Japanese terminology, and test their memory skills. It is a cooperative experience with two users: one in a VR environment, and the other using a mobile phone. The two users will enter a “game room” using a specific code for that room, allowing them to seamlessly connect with each other and ensuring that no unexpected users enter the room. The user on mobile will act as the ‘Master’, and the user in VR will act as the ‘Student,’ and both users will interact in a manner similar to a traditional “Simon Says” game. The user on the mobile device chooses a sequence of actions that represent basic Kendo techniques, and the order of those actions, and the user VR must then carry out the sequence to the best of their abilities. The indicators with which actions are signalled will provide the user with less context in English as the difficulty level increases, forcing the user in VR to learn the equivalent Japanese terms and associate them with the various actions provided to them. These actions will consist of swinging the virtual Kendo sword at a traditional wooden training dummy to hit indicated targets at specific speeds. The game will react to the user’s actions in VR with a visual response in accordance with their performance, such as, “Poor”, “Good”, “Great”, or “Perfect.” This response will inform the user of how well they carried out the sequence of instructions provided to them by their counterpart on a mobile smart device. Once the user in VR has finished the sequence of actions they will be given the option to change the difficulty of the sequence given to them, repeat the previous sequence, or recieve a new sequence from the Master. Both users have the ability to leave the game room at any time, except for when the instructions are being executed by the user in VR.

1.2 Audience

Kendō Gakkō’s target audience consists of individuals who are interested in VR, Kendo, and Japanese culture. According to market research at Pew Research Center, 60% of people aged 18-29, and 53% of people aged 30-49 play video games [1], therefore we decided to target the age range of 18-35 years. This allows us capture the entirety of the 18-29 year-old age group, as well as the portion of the 30-49 year-old age group that is more likely to be active online. VR has become popular with technology enthusiasts, and the majority of the VR and gaming demographics also falls into the chosen age range of 18-35 years.

The main distribution method for the project will be GitHub, as the project is publicly available for other people to view and fork. This allows the software to be distributed as Shareware, which is digital software that is distributed online for free, and allows word of mouth to act as its marketing strategy. Because the target audience for Kendō Gakkō consists mainly of technology enthusiasts, it is likely that the software will be marketed by the audience within itself. The game will also be free software, which makes the likelihood of people trying the game and recommending it to others much higher than if the game was being sold. Many people aged 18-25 have a statistically lower income than older age ranges, so a free game for a new technology can be very

appealing. The shareware distribution method, and the lack of monetary investment by the user, will enable a much wider range of people to play the game.

1.3 Technical Requirements

Kendō Gakkō will require a variety of software and hardware tools to develop and run in order to provide users with a high quality and optimized experience. The project front-end will be primarily built and run using a powerful web framework called “A-Frame”, commonly used to develop web-based virtual reality experiences [2]. Other components of the project, such as a universal landing page and the mobile user interface, will be written in HTML, CSS, and JavaScript (JS) web languages. The backend server, managing multi-user connectivity and interaction, will be built using an open-source, cross-platform JavaScript run-time environment called “Node.js” [3]. The team will be using the Microsoft Visual Studio Code source code editor to write, edit, and test all source code throughout the development of the project.

In contrast, project assets used within the VR and mobile user environments will be created with a separate set of creative tools intended to bring the world of Kendō Gakkō to life while also promoting a smooth and agile workflow. Adobe Photoshop and Adobe Illustrator will be used to produce all 2D digital graphics for use in both the mobile and VR user experiences. By building Kendō Gakkō from the ground up, the team will need to create a variety of icons for user interface designs, infographics for user tutorials, and vector images to decorate the VR environment. The team will also be creating custom sound effects and music using Adobe Audition and Garageband or may utilize audio elements from reputable royalty free sources, such as Epidemic Sound [4] or Artlist [5], as an alternative. All 3D models used within the VR environment, such as the dojo structure and shinai practice sword, will be created using Autodesk Maya due to its robust toolset and the team’s prior experience using the software on past projects. Associated textures for 3D models will be generated using Substance Painter to take advantage of the software’s improved workflow and intuitive features.

All project source code and assets files will be stored and hosted on Github, a web-based hosting service commonly used for managing source code distribution and version control. Each team member will be actively contributing to the main project repository during development and merging changes to a “develop” branch. The develop branch will then be merged with the “Master” branch for each major milestone or deliverable. This hierarchical branch system will reduce the possibility of code-breaking changes being introduced into the project’s primary source code. Additionally, milestone blog posts from each team member regarding individual progress, challenges, and success may be accessed through a link in the project repository wiki.

As previously mentioned, Kendō Gakkō is a cooperative experience that will involve two users interacting with separate and very different devices. The user engaging in the role as the Master is encouraged to use a smartphone for the best user experience but can use a tablet, desktop computer, or laptop with an internet connection as alternatives to fulfill their role. When the Master is using a wireless smart device (i.e. smartphone or tablet), it is recommended that they do

so in an obstacle-free play space of approximately 2m x 2m to ensure they can use all available features comfortably and safely. The user engaging in the role of the Student will require a full Oculus Rift setup including the headset, Touch controllers, and sensors (Fig. 1.3-1) in addition to an internet-enabled and VR-capable desktop computer or laptop. Similar to the Master, it is recommended that the Student has an obstacle-free play space of approximately 3m x 3m to ensure they can use all available features comfortably and safely.

Figure 1.3-1: In order to experience the VR portion of Kendō Gakkō, users will need a full Oculus rift setup as follows: 1 x Oculus Rift headset, 2 x Oculus Touch controllers, 2 x Oculus Sensors, and a computer with the necessary ports to support all Oculus Rift hardware [6].

A complete and comprehensive list of all language, software, and hardware technologies necessary to successfully produce Kendō Gakkō as well as recommendations for comfortable user operation are as follows:

Production

- Hypertext Markup Language (HTML)
- Cascading Style Sheets (CSS)
- JavaScript (JS)
- A-Frame
- Node.js
- Microsoft Visual Studio Code
- Adobe Photoshop
- Adobe Illustrator
- Adobe Audition
- Garage Band
- Autodesk Maya
- Substance Painter
- GitHub

Operation

- Master - (1) mobile smart device, desktop PC, or laptop with internet access
  - 2m x 2m obstacle-free play space for mobile smart devices
- Student - (1) Oculus Rift setup
  - Headset
  - Touch controllers
  - VR capable PC with internet access
  - 3m x 3m obstacle-free play space

1.4 Key Feature List / Scope

The following section will review the features that make up the heart of the Kendō Gakkō experience. All listed features have been given a “priority” rating that expresses the importance of each feature with respect to the critical path of the project. Higher rated features will be developed first as they make up the building blocks that features of lower ratings depend on and will be built on top of. All features have been organized into Technical, Design, and Interaction Features and are as follows:

1.4.1 Technical Features

Feature	Priority	Description
Web-based 3D Graphics Framework	1	The basic concept of Kendō Gakkō requires one of two users to be in immersed in VR which in turn requires a 3D environment for them to inhabit. Additionally, it is necessary to use a 3D framework that is optimized for use on the web for the project to run smoothly, let alone run at all. A-Frame is an HTML based framework optimized for creating web-based virtual reality experiences that will be used to build the foundation of the project and is the keystone of delivering the minimum viable product (MVP).
Multi-device Compatibility	2	Kendō Gakkō is intended to be experienced by two users on separate devices, one using the Oculus Rift and the other using a mobile smartphone. This core functionality is at the heart of the user experience and essential to critical path of the project. The whole experience will fail to deliver on the original concept if either user is unable to interact with the project on their intended device. Additionally, multi-device support will expand the list of compatible devices beyond the original two core devices and allow the project to be accessible to a wider audience.
Multi-user Connectivity	3	In order for the cooperative experience of Kendō Gakkō to function, a server for handling communication between the two users ("Master" and "Student") is critical; one will not function as intended without the other. Node.js will be used to build the server(s) necessary for running the project's multi-user functionality and is another integral part of the core experience. This is a fundamental component of the project and is required in order to deliver our MVP.

Asset Management	4	A system to load and manage assets within the A-Frame environment will be a crucial building block to ensure the project as a whole can operate reliably and consistently over varying network connections and on the necessary devices. Efficiently organizing and managing the multitude of 3d models, graphics, sounds effects, and other environmental components, like lighting, will be of utmost importance for ensuring the project
Mobile User Interface	5	Designing and implementing an effective interface by which the "Master" user will interact with the "Student" user will be a significant cornerstone in the development of the project's fundamental features. The mobile interface will rely on the foundation established in A-Frame, in addition to server connectivity and device support, and will be the final foundational component of the project on which all other features will be built.
Oculus Rift Headset Display	6	Once fundamental frameworks are in place, the next step is to properly adapt the display of the virtual environment for users viewing it with an Oculus Rift headset. This involves rendering a slightly different image for each "eye" of the headset to simulate a realistic sense of depth. Other user-focused features will implemented once a reliable and precise visual stage has been established to mitigate some common side effects of VR, such as motion sickness. Adjustments to previously established elements of the A-Frame framework may be required for optimizing outcomes affecting the VR display such as framerate and asset load times to avoid jarring or disorienting visuals.
Oculus Rift Headset Motion Tracking	7	The Oculus sensors will be used in combination with the Oculus Rift headset to track the position and orientation of the user's head in real time. This is keystone feature of virtual reality interfaces that allow users to freely look around their environment through the headset display with a sense of presence and realism. Similar to the headset display, the precision of the headset motion tracking may have to be calibrated to ensure a smooth and comfortable user experience.

Oculus Touch Controller Motion Tracking	8	In addition to the ability to freely look around their environment with the Oculus Rift headset, users will use Oculus Touch controllers to track the position, orientation, and grip of their hands in real time. By combining Oculus Touch with Oculus Rift, users will be able to both observe and eventually interact with the virtual environment around them in real time to further heighten their sense of presence within the space.
Realistic Object Interaction	9	A physics engine will be implemented to manage the physical interaction between the user and virtual objects. The precise motion tracking information from the Oculus Touch controllers will allow the user in VR to intuitively touch, pick up, orient, and move objects in the environment around them. These physical interactions will require detailed calibration in order to feel as natural as possible and are the basis of the core gameplay loop. The physics system will measure the speed, direction, and force of objects movements and interactions to simulate real-world kinematics.
Audio Playback	10	A diverse range of sound effects and music will be implemented to promote an immersive and enjoyable environment. A-Frame natively supports 3-dimensional audio which will be used to create directional audio cues for informing the user of their performance, for example. Certain objects within the virtual environment may produce sounds when interacted with and will allow the user to experience varied audio levels based on proximity and speed.
Smart Device Accelerometer Tracking	11	Similar to the Oculus Rift headset motion controls, users on mobile smart devices, such as smartphones and tablets, will be able to view the virtual environment in 360 degrees. The device's built in accelerometers will provide the information necessary to track the 3-dimensional orientation in real time, allowing users to freely view the virtual environment as if their device were a window into another world. This functionality is not a core aspect of the user experience but can provide an enhanced sense of immersion if users choose to enable it.

Oculus Touch Controller Haptic Feedback	12	To further enhance a user's sense of presence in VR, the motors in the Oculus Touch controllers will be used to generate vibrations and simulate the feeling of physical impact within the virtual environment. Although this feature is not vital to the core experience, it will greatly enhance the user's sense of immersion by allowing them experience the sense of touch.

1.4.2 Design Features

Feature	Priority	Description
Authentic 3D Environment	1	The virtual game environment will be an authentic representation of a kendo dojo. Our team will make a strong effort to incorporate elements of historical accuracy while also adding some creative additions of our own. The environment will be fully modeled and textured to operate efficiently within the limitations of web technologies while evoking a strong sense of presence and atmosphere. Users will be able to freely view the environment in 360 degrees while wearing an Oculus Rift headset or after selecting it as an option on mobile smart devices.
Intuitive Mobile User Interface	2	Users engaging in the role of the Master will make use of minimalistic and comprehensive user interface that will allow them to define a sequence of techniques for the student in VR to execute. The Master will build a sequence at a length of their choice based on a bank of techniques and targets like a slash to to the head or a thrust to the torso, for example. The user interface will involve a variety of custom iconography and imagery that will incorporate aspects of Japanese language as well as kendo techniques and practices.

Introduction to Japanese Martial Art of Kendo	3	Kendō Gakkō, as the name suggests, will introduce users to kendo, a traditional Japanese martial art focusing on combat with the sword. Users will learn basic kendo striking techniques, traditional terminology, and common practices all within a virtual interpretation of a traditional kendo dojo. A strong effort will be made to consult local reputable sources to ensure the accuracy of cultural representations within the project including, but not limited to, the Carleton University Kendo Club and the Carleton University Japanese Association.
Appropriate Incorporation of Japanese Language and Cultural Imagery	4	The project will include culturally accurate Japanese language, imagery, and iconography to respectfully introduce users to Japanese language and martial arts. A strong effort will be made to consult reputable sources to verify the accuracy of cultural representation with the project including, but not limited to, the Carleton University Kendo Club and the Carleton University Japanese Association.
Cooperative Gameplay	5	The gameplay of Kendō Gakkō is a cooperative experience where two user, the Master and the Student, interact with one another to define and execute a set of Kendo techniques against an unsuspecting practice dummy. The Master is responsible for defining an ordered sequence of techniques on a mobile smart device for the student to attempt in virtual reality using the Oculus Rift headset and Touch controllers. The Student will take hold of an authentic bamboo shinai in virtual reality and strike a wooden training dummy at specific points, and with enough force, according the the Master's instructions.
3 Different Levels of Difficulty	6	Kendō Gakkō will feature 3 separate levels of increasing difficulty for users to explore. Each level will engage users with progressively more challenging striking combinations and require them to learn, and eventually memorize, Japanese kanji in order to execute a sequence of techniques correctly.

3D modeled Kendo Shinai	7	Users in VR will take hold of a fully modeled and textured kendo shinai that was designed to be congruent with modern day examples. Users will be able to slash, thrust, and swing an accurate virtual shinai replica to strike dynamic targets on a wooden training dummy and experience the art of kendo first hand.
3D Modeled User Hands	8	In order to promote a sense of presence within the virtual environment, users engaging as the Student with a full Oculus Rift setup will have a fully modeled pair of hands within the virtual environment that will mimic their movement in real time. User will be able to move their virtual hands freely while pointing, grabbing, and manipulating objects similar to how they would in real life.
Dynamic Strike-Feedback Graphics	9	As users engaging as the Student complete a sequence on techniques by striking a practice dummy in VR, there will be a myriad of dynamic graphics to provide exciting feedback on the quality of the user's technique. The faster and more accurate each strike is, the better the grades the user will earn. These graphics are intended to add excitement and enhance the perceived challenge of the experience to encourage a sense of competition between players as well as a sense of satisfaction when earning a "perfect" grade for each strike.

1.4.3 Interaction Features

Feature	User	Priority	Description
Limited 3D Motion	Student	1	User in VR will be able to take advantage of the motion tracking functionality between the Oculus Rift headset and Oculus Sensors to freely move within a limited space (approximately 3m x 3m) inside their virtual environment.
Object Manipulation	Student	2	Users in VR will be able to take advantage of the motion tracking functionality between the Oculus Touch controllers and Oculus Sensors to grab, orient, and move objects in the environment around them.

Kendo Techniques	Student	3	Users in VR will combine their ability to move within the 3D space and manipulate objects to take hold of an authentic replica kendo shinai and strike target on a training dummy in accordance with a sequence defined by the Master on their separate device. Users will have to use their natural body awareness and skills to strike targets by slashing and thrusting while they hold the shinai in VR; the faster and more accurately they strike, the higher their grade for each technique will be.
Bowing	Student	4	Users in VR will receive a sequence of techniques from the Master on a separate device at which point they will have to use the motion tracking of the Oculus Touch controllers and put their hands by their side before bowing to accept the sequence. This action is a tradition in Kendo where students bow to their instructors when receiving a lesson and to their sparring partners before engaging in a match. In this case, the user is bowing to both the Master to accept the sequence of techniques and to the practice dummy before executing the sequence.
UI Navigation	Master	1	Users on mobile smart devices, PCs, or laptops acting as the Master will interact with an intuitive user interface by swiping/click-and-dragging and tapping/clicking.
Sequence Declaration	Master	2	Users acting as the Master will define a sequence of techniques before sending it off to the Student for execution and can review the Student's progress through the sequence in real time.

Immersive Mode	Master	3	While the Student is executing the Master's defined sequence, the Master has the option to enable a mode that will put them into the same VR space as the Student. The Master will then be able to make use of the accelerometer in their mobile smart device by physically moving their device around them to look around the environment and watch the Student attempt their techniques in real time. Alternatively, if the Master is using a PC or laptop, they will be able to explore Immersive Mode by clicking and dragging their mouse around the screen to change their viewing angle.

1.5 High Level Development Plan

Kendō Gakkō will be developed over a period of 10 weeks in accordance with Agile project philosophies and SCRUM methodologies to promote a collaborative, interdisciplinary, and flexible work environment to deliver functional software at regular intervals. The duration of development will be split into ten one-week sprints with defined deliverable goals at the end of each sprint culminating in the final project delivery at the end of the last sprint. Each sprint, their timeframe, and deliverables are as follows:

Milestone 1 | January 24th

General:

- Established Github environment
- High level technical, design, and interaction features
- Oculus Rift VR headset, Touch controllers, and sensors acquired

Milestone 2 | January 29th

General:

- Basic A-Frame environment initialized
- Completed Design Document
- High level work-hour plan and forecast
- Completed Github backlog
- Oculus Rift integration research
- Physics system integration research

Milestone 3 | February 5th - First Week of Production

Software Development:

- Oculus Rift integration
- User-object interaction (grab, hold, orient)
- Object physics & collision detection

UX Design:

- Responsive universal lander web page
- HTML framework for mobile web pages

3D Design:

- Insert proxy geometry into environment
  - Training dummy
  - User hands
  - Shinai (bamboo sword)
  - Dojo environment
- Model & Texture Shinai

Milestone 4 | February 12th - Alpha Presentation

Software Development:

- User device detection (mobile vs desktop/VR)
- User-object physics based interaction with objects (speed, momentum, inertia)
- Back-end infrastructure to connect “Master” and “Student”

UX Design:

- CSS styling for mobile graphical user interface
- Spatial sound effects for physical interactions in VR

3D Design:

- Modeled & textured training dummy
- Modeled & textured VR user hands
- Basic indoor lighting

Milestone 5 | February 26th

Software Development:

- Send/receive instructions between ‘Master’ and ‘Student’
- Dynamic instruction display based on “Master” input (for Easy difficulty)
- Binary sequence instruction states (pass/fail)

UX Design:

- “Student” technique sequence response graphics for three quality levels
  - “Poor”
  - “Good”
  - “Perfect”
- “Student” technique sequence target graphics in three language formats
  - English
  - Romanji

- Kanji

3D Design:

- HDR skydome
- Optimized shadow maps

Milestone 6 | March 5th

Software Development:

- User gesture recognition
- Interactive physical VR menu integration
- Sequence End User Interaction
  - Retry sequence
  - New sequence
  - Change difficulty
  - Exit
- Visual user feedback Integration in VR for:
  - Failed/successful technique
  - Dummy hit
  - Waiting for Other User
  - Sequence Start
- Immersive Mode for mobile user

UX Design:

- Graphics For Loading/Waiting State Animations
- Mobile Interface JavaScript Functionality

3D Design:

- Miscellaneous Environment Detail Proxy Geometry

Milestone 7 | March 12th - Beta Presentation

Software Development:

- User Strike Quality Scale
  - Index value for each level
  - Connect Visual Feedback to index values
  - User Grade at end of sequence
- Interactive Physical VR Menu Workflow Implementation
  - Connect menu sections

UX Design:

- Ambient Background Music

3D Design:

- Modeled & Textured VR Dojo Environment

Milestone 8 | March 19th - User Testing & Misc. Bug Fixes

General:

- User Testing

- Miscellaneous Bug Fixes

Software Development:

- User Difficulty Levels
  - Change Instruction Display method

UX Design:

- VR Dojo Environment Decorative Artwork

3D Design:

- Modeled & Textured Miscellaneous VR Environment Details

Milestone 9 | March 26th

General:

- Implement User Testing Feedback
- Miscellaneous Bug Fixes

Software Development:

- Register User Strikes
  - Slashes
  - Jabs

UX Design:

- Supplementary Sound Effects

3D Design:

- Miscellaneous Geometry Optimizations

Milestone 10 | April 2nd - Final Presentation & Delivery

General:

- Bug Fixes
- Stretch Goals

1.6 Team Member Roles and Bios

In this project, there are four major areas of development: Project Management, 3D Modelling, UX Design, and Programming. Each member of the Kendō Gakkō team possesses a primary role and secondary role for this project belonging to two of the four aforementioned areas of development. For their primary role, each team member has been named the lead of one of the four areas of development according to their highest level of experience and strongest level of interest, and their secondary role dictates the nature of the majority of the other work that they will be performing. However, given that our team as a whole is multi-functional and has experience in each area of development, each team member will be responsible for contributing to any tasks that are available and need to be completed if all of their primary tasks for each sprint have been completed.

Matthew Donoghue | Project Manager, Developer

For the duration of this project, Matthew's primary role will be the team's Project Manager. Matthew has one year's worth of professional experience in project management after having completed three consecutive co-op work terms as a Project Coordinator at You.i TV from January until December of 2018. He has a wealth of knowledge pertaining to sprint planning, project resource allocation, and productivity tracking, and will be responsible for monitoring the project's overall progress and ensuring that sprints are planned appropriately and realistically.

Matthew will also be acting as one of the team's Developers as his secondary role in this project. He has experience working with A-Frame after having completed a project in his Design Studio I course, as well as experience in web development and a general interest in programming.

Hannah Perks | UX Design Lead, 3D Artist

For the duration of this project, Hannah's primary role will be the team's UX Design Lead. Hannah is a very people-oriented individual, allowing her to have a strong sense of users' wants and needs, to predict potential user experience flows, and to be highly responsive to feedback during user testing. She has gained experience in user interface design as well as the overall employment of user-centric design from past courses such as Human-Computer Interaction, and will be responsible for ensuring that Kendō Gakkō's overall experience is reflective of the research gathered about Kendo and the Japanese language, and is tailored to our target audience's needs.

Hannah will also be acting as one of the team's 3D Artists as her secondary role in this project. She has experience working with 3D software such as Autodesk Maya from her Design Studio II course, as well as artistic abilities that will assist in creating high-quality textures for our models.

Christa Buttera | Lead 3D Artist, UX Designer

For the duration of this project, Christa's primary role will be the team's Lead 3D Artist. Christa has experience in various areas of 3D design including 3D modelling, lighting, texturing, and environment layout design. She has experience working with 3D software such as Autodesk Maya from her Design Studio II course and working with asset layout in a 3D environment using A-Frame in her Design Studio I course, and will be responsible for monitoring the progress and delivery of 3D assets as well as ensuring that the game environment is laid out and lit appropriately.

Christa will also be acting as one of the team's UX Designers as her secondary role in this project. She has experience in the development of UI assets, as well as the creation of public-facing, user-centered multimedia products in her three consecutive co-op terms with the City of Ottawa from January until December of 2018.

Braeden Timlin | Lead Developer, UX Designer

For the duration of this project, Braeden's primary role will be the team's Lead Developer. Braeden has over a year's worth of experience working in development as a Software Tester at You.i TV since January of 2018. He has extensive experience using GitHub and has a keen eye for detail

and a solution-oriented way of thinking that allow him to spot code issues and solve them efficiently, and will be responsible for ensuring that the code for Kendō Gakkō is clean, organized, and as efficient as possible as well as ensuring that our GitHub repositories are organized properly and in working order.

Braeden will also be acting as one of the team's UX Designers as his secondary role in this project. He has gained experience in UI asset development, user testing, and UX research from the completion of the Human-Computer Interaction course that will allow for the creation of a well-rounded and rich user experience within our game.

Section 2.0

User Interaction Specification

2.1 Experience Flow & Architecture

The following user flow and architecture has been modeled after a typical user interaction for both roles of the game, the Master and the Student (Figure 2.1-1). Both user roles will operate in conjunction with one another, however, being networked, they do not require that both devices are within a certain vicinity. As a result, it was decided that the user experience flow needs to be, for the most part, as linear as possible to mitigate user error and promote a pleasant user experience to both players. With that in mind, it is essential to give users a sufficient amount of feedback to clearly communicate the current state of the game as well as any tasks to be performed at all times. For example, after the Student has selected a level of difficulty, a “waiting” state will be initiated in VR to inform the Student they must wait for the Master to define a sequence on techniques before proceeding. By integrating distinct game states and clear feedback, Kendō Gakkō aims to deliver a cohesive and intuitive experience for all users. Please find the User Experience & Architecture Flowchart on the next page (page 21).

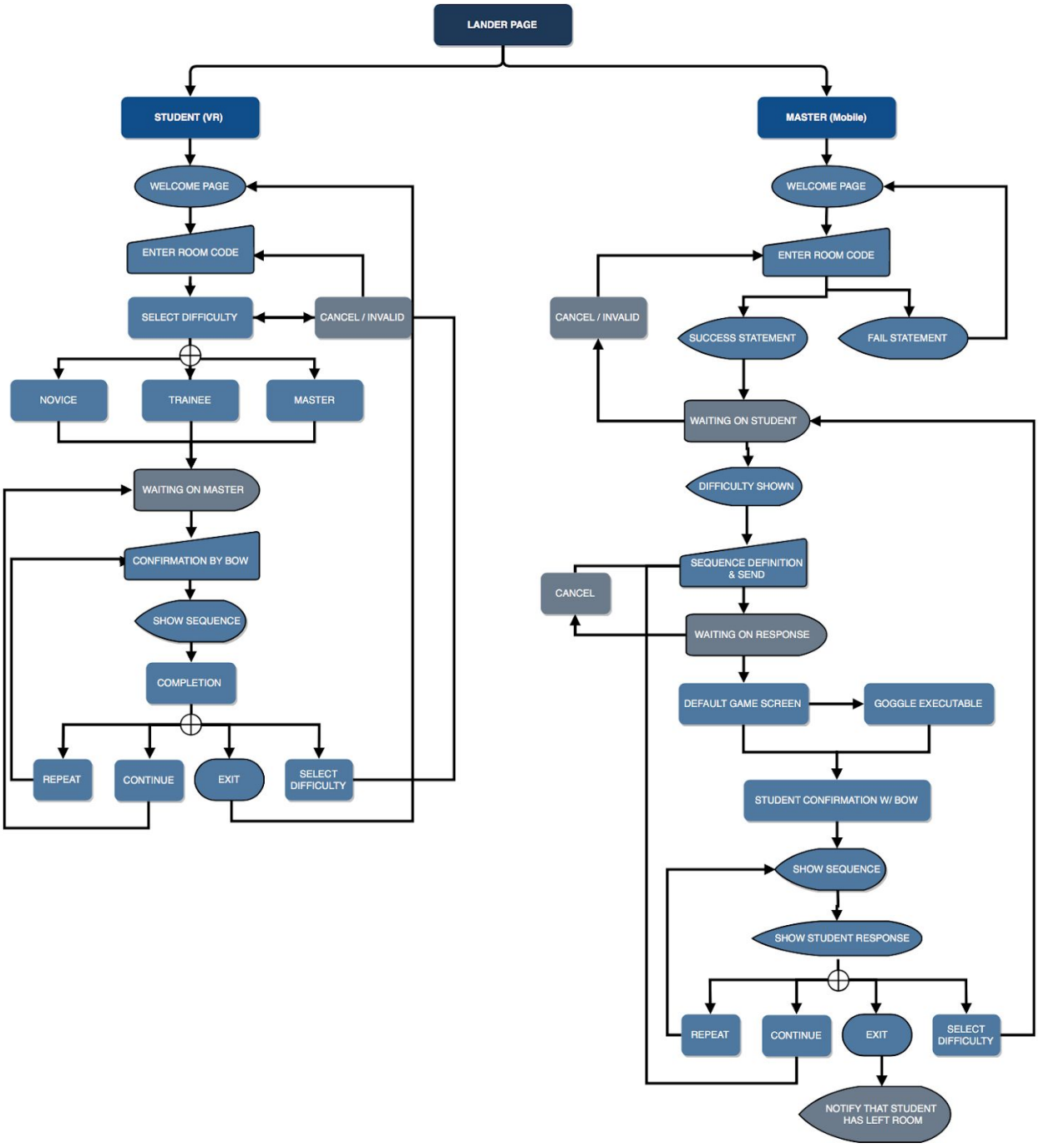
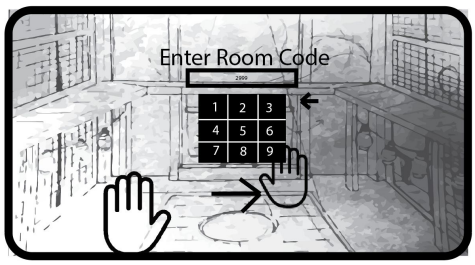
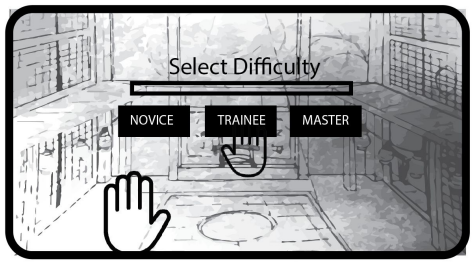
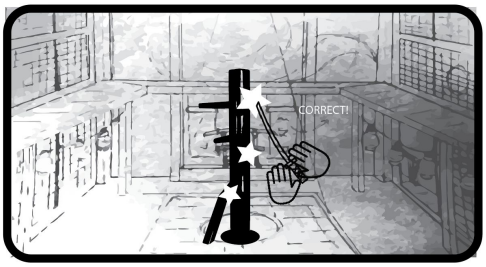
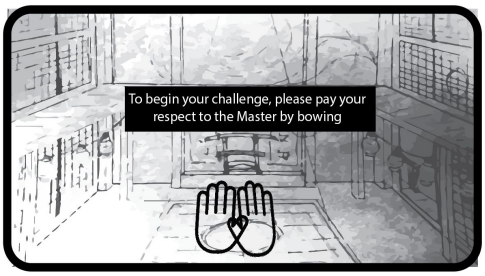


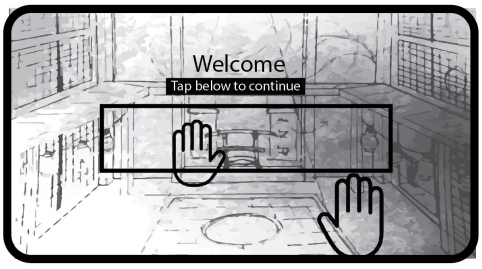
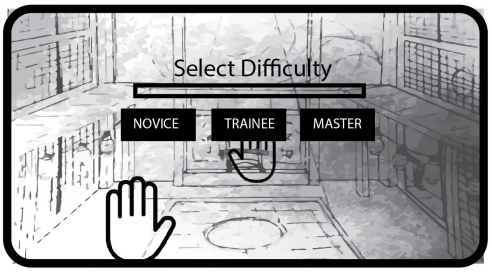
Figure 2.1-1: User Experience & Architecture Flowchart of typical use cases for each user type

2.2 Wireframes & Storyboards

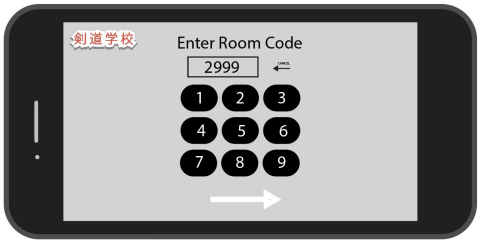
2.2.1 Student Wireframes & Storyboards (Oculus Rift User)

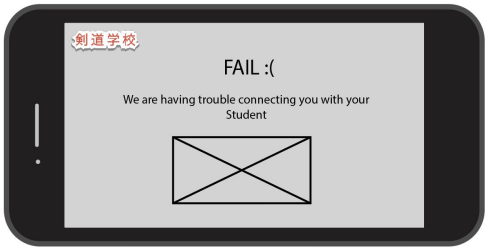
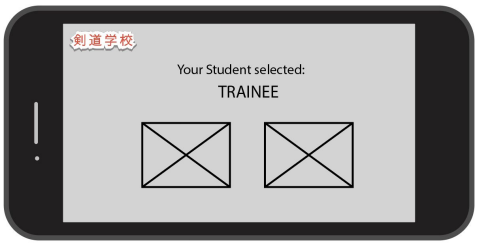
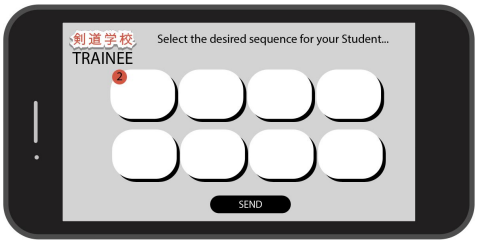
Interface Name	Visual	Description
Welcome Page		› This is an introduction page to the game play › The Student player will use the Touch Controller to "tap" to continue, thereby bringing them to the next interface › The area shown is the available space to tap in order to continue
Enter Room Code		› Digit box appears in front of users › The Student must reach in front in order to press the keys of the room code and then press the arrow to continue › If the Student makes an error while typing in the code they have the option to go back and retype the code
Select Difficulty		› 3 options are presented to the Student › They must select one of the following in order for the Master to select the sequence based on the selected difficulty
Waiting on Master		› This is a buffer page › It is informing the Student that the Master is putting together a sequence in which they must execute › The Student can move their arms around and look around the interface while the loading message is present in front of them

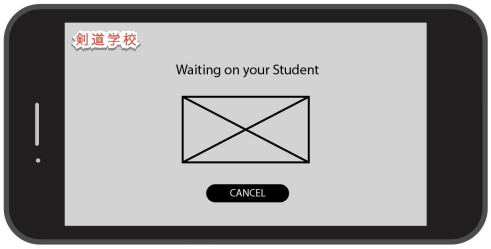
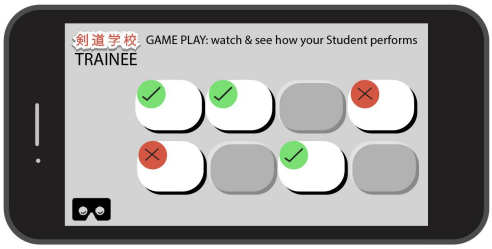
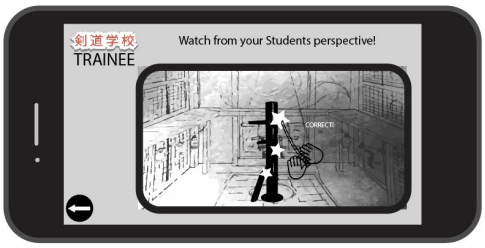
Confirmation by Bow		› User is informed by display that they must bow in order to proceed › The Student must put both hands together and bow to confirm and continue
Show Sequence		› Depending on the chosen difficulty level, the student will receive a maximum of 10 techniques from the Master to be performed by using the sword and hitting the training dummy › The Student then must execute the sequence, as prompted in front of them
Completion		› Statistics regarding the sequence and how the Student performed › Beneath, 4 boxes showing “Repeat”, “continue”, “Exit”, and “Select Difficulty” › The Student must swipe with their sword to crack the box that they want to select
Repeat		› Refer to “Confirmation by bow”
Continue		› Refer to “Waiting on Master”

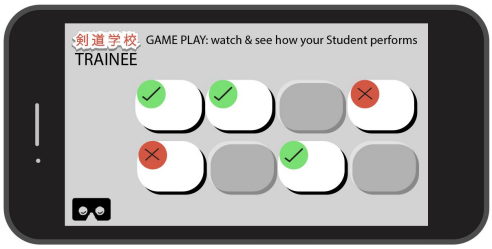
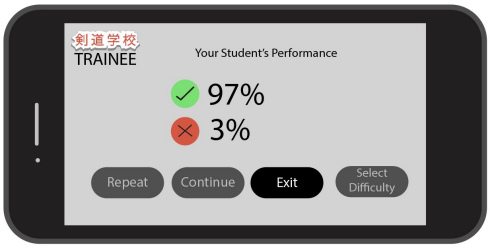
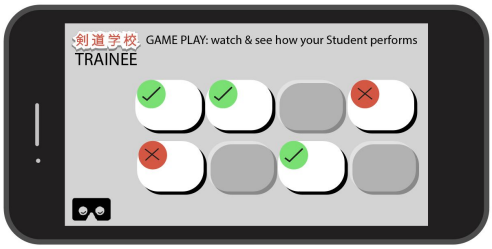
Exit		› Refer to “Welcome page”
Select Difficulty		› Refer to “Select Difficulty”

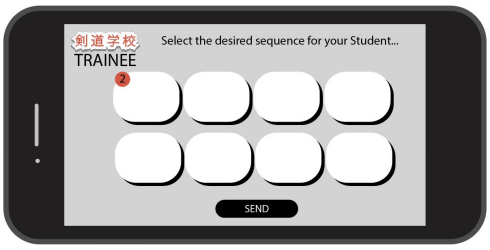
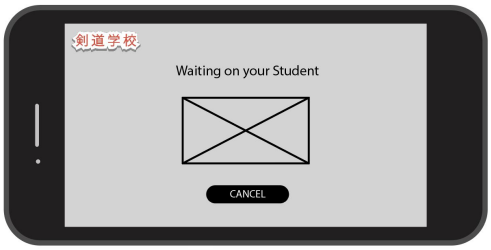
2.2.2 Master Wireframes & Storyboards (Mobile User)

Interface Name	Visual	Description
Welcome Page		› This is an introduction page to the game play › The Master player must tap the touch screen on the mobile device in order to proceed › The area shown is the available space to tap in order to continue
Enter Room Code		› Digit box appears in the centre of the screen › The Master must touch the digits on the screen, then press the arrow in order to continue on › If the Master makes an error while typing in the code they have the option to go back and retype the code

Success Statement		› This page will only show if the Master successfully enters the correct (corresponding) room code into the digit box
Fail Statement		› This page will only show up if the Master incorrectly types in the room code, once this screen shows up, it will then redirect the Master to re-enter the room code
Waiting on Student		› The interface is primarily for feedback for the Master, showing that the student is selecting the difficulty › This interface will change once the sequence has been selected
Difficulty Shown		› This interface is to inform the Master of which difficulty was chosen by the Student › The Master must tap the screen to continue
Sequence Definition & Send		› The Master now has the ability to select up to 10 moves in order to send to the Student, and for them to perform › The Master must select the icons in the order that they want the student to perform them › If the Master selects the same move multiple times, an pop-up in the top corner of that move/icon will appear to indicate how many times the Master has selected that specific move › Once the Master has selected the

		sequence, they must confirm and press the send button in the bottom right corner
Waiting on Response		› This interface is for feedback for the Master, to show that the Student must take action › The Master does not have to take action on this interface, they must just wait › If the Master feels they have been waiting for too long, or decides to change the sequence, they have the ability to press the button underneath the display message that reads, Cancel.
Default Game Screen		› This interface displays the game play, showing the sequence of the hits on the icons that the Master has selected › If the Student performs the correct moves, a check mark will appear in the top corner of the icon › If the Student performs the incorrect move, a “x” mark will appear in the top corner of the icon
Goggle Executable		› This interface can only be shown if the Master presses the VR goggle icon in the bottom left corner of the Default Game Screen › Once they press this, it will direct the Master to this page › This interface will show the gameplay from the Student’s perspective, giving the Master live gameplay › If the Master wants to return back to the Default Game Screen, they can do so by hitting the back icon in the bottom left corner

Student Confirmation w/ Bow		› This screen is displayed within the Default Game Screen and the Goggle Executable › A message will appear to confirm that the student had bowed, meaning gameplay can take place
Show Sequence		› This screen is displayed within the Default Game Screen and the Goggle Executable › This interface displays the sequence of moves tasked to the Student by the Master › Refer to Default Game Screen and the Goggle Executable for game play interactions
Show Student Response		› This interface is a statistics page to display the Students rankings for the difficulty and moves performed › Beneath, 4 boxes showing "Repeat", "continue", "Exit", and "Select Difficulty" › The Master does not interact with these boxes, as a message states it is waiting on the Student to decide
Repeat		› Refer to "Show Sequence"

Continue		› Refer to “Sequence Definition & Send”
Exit		› This interface will show only if the Student has decided to “Exit” › It will notify the Master that the Student has left the room
Select Difficulty		› Refer to “Waiting on Student”

2.3 Diagrams & Physical Layout

As previously mentioned, there are two possible roles that a user can play in this game: the Student or the Master. The physical layout required to play Kendō Gakkō is structured according to the role chosen by the user and, by extension, to the technology required for each role.

While playing as the Student, the user’s physical space will require an obstacle-free Play Area of 3m x 3m (Fig. 2.3-1, label 1) to allow them to interact with the game environment without risk of collision with other individuals or surrounding objects. The user must remain within this Play Area at all times, and be equipped with an Oculus Rift headset (Fig. 2.3-1, label 2) and one Touch Controller per hand (Fig. 2.3-1, label 3). The user’s VR-capable computer (Fig. 2.3-1, label 4) must be outside of the Play Area, but close enough to the user that it can connect to their headset safely, and their monitor (Fig. 2.3-1, label 5) must be placed within the room and outside of the Play Area to allow them to launch the game before equipping their headset. The two Oculus sensors should be placed in the standard positioning in front of where the user's headset will be. It is not recommended that the user deviate from this sensor configuration to use Oculus's 2-Sensor 360° Experimental Setup [7], as it requires a larger Play Area and has only been proven to work to its fullest potential with sitting games. Once the user’s setup has been configured to meet the requirements indicated above, they will be able to use their Oculus Rift headset and Touch

Controllers to safely interact with the elements in the game environment (shown in blue in Figure 2.3-1 below) within the boundaries of their Play Area.

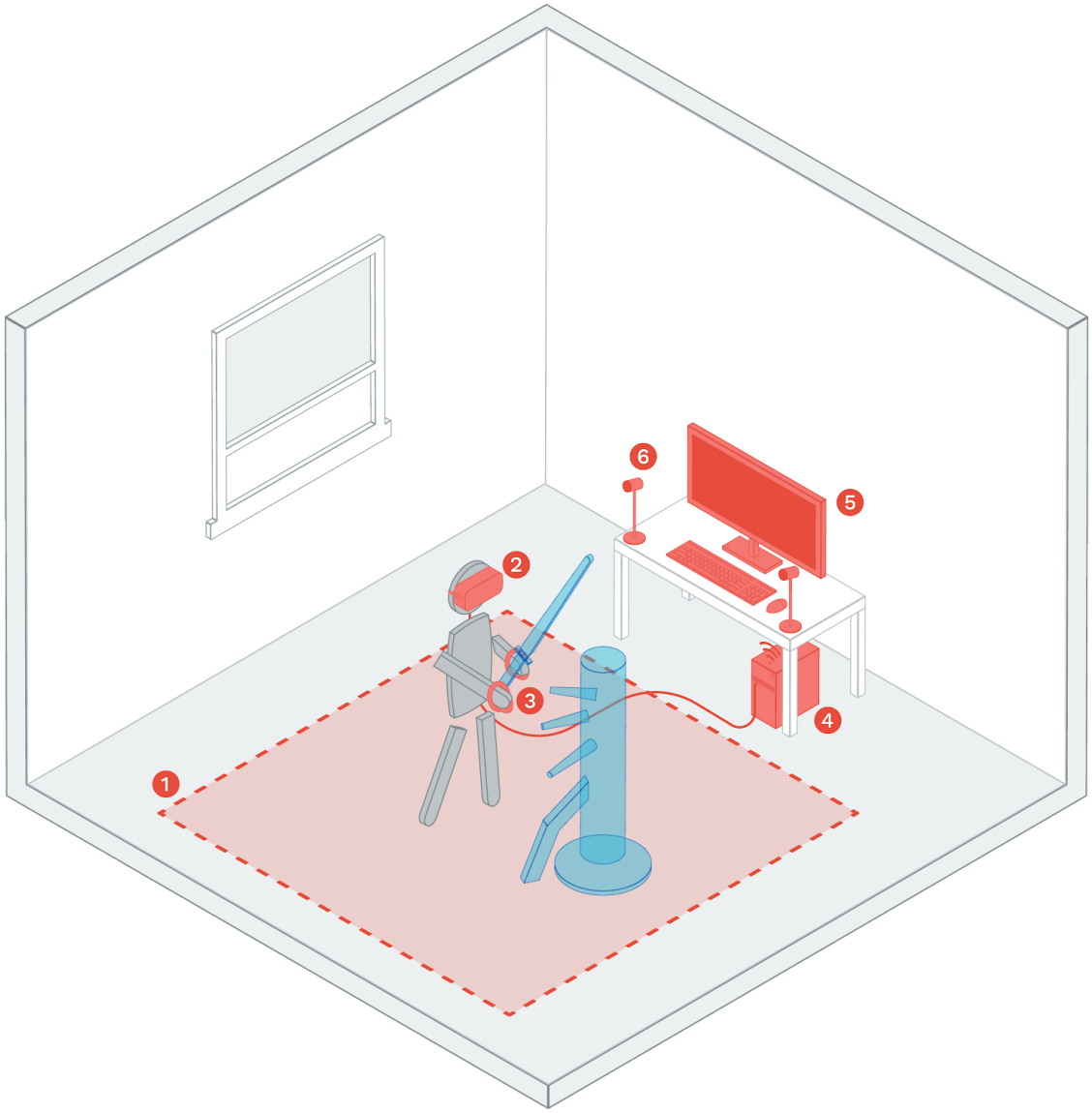


Figure 2.3-1: Physical layout diagram for user playing in VR as the Student

While playing as the Master, the user's physical space will require an obstacle-free Play Area of 2m x 2m (Fig. 2.3-2, label 1) to allow them to observe the game environment without risk of collision with other individuals or surrounding objects. Unlike the Student, the Master's physical position is not tracked within the 3D game environment, so the user must therefore be sure to maintain a 2m x 2m Play Area and remain in the centre of this Play Area at all times. They must also be equipped with a mobile device (Fig. 2.3-2, label 2) with a strong internet connection (Fig. 2.3-2, label 3). Once the user's setup has been configured to meet the requirements indicated

above, they will be able to use their mobile device to safely observe the 3D game environment within the boundaries of their Play Area and to interact with the second user playing as the Student.

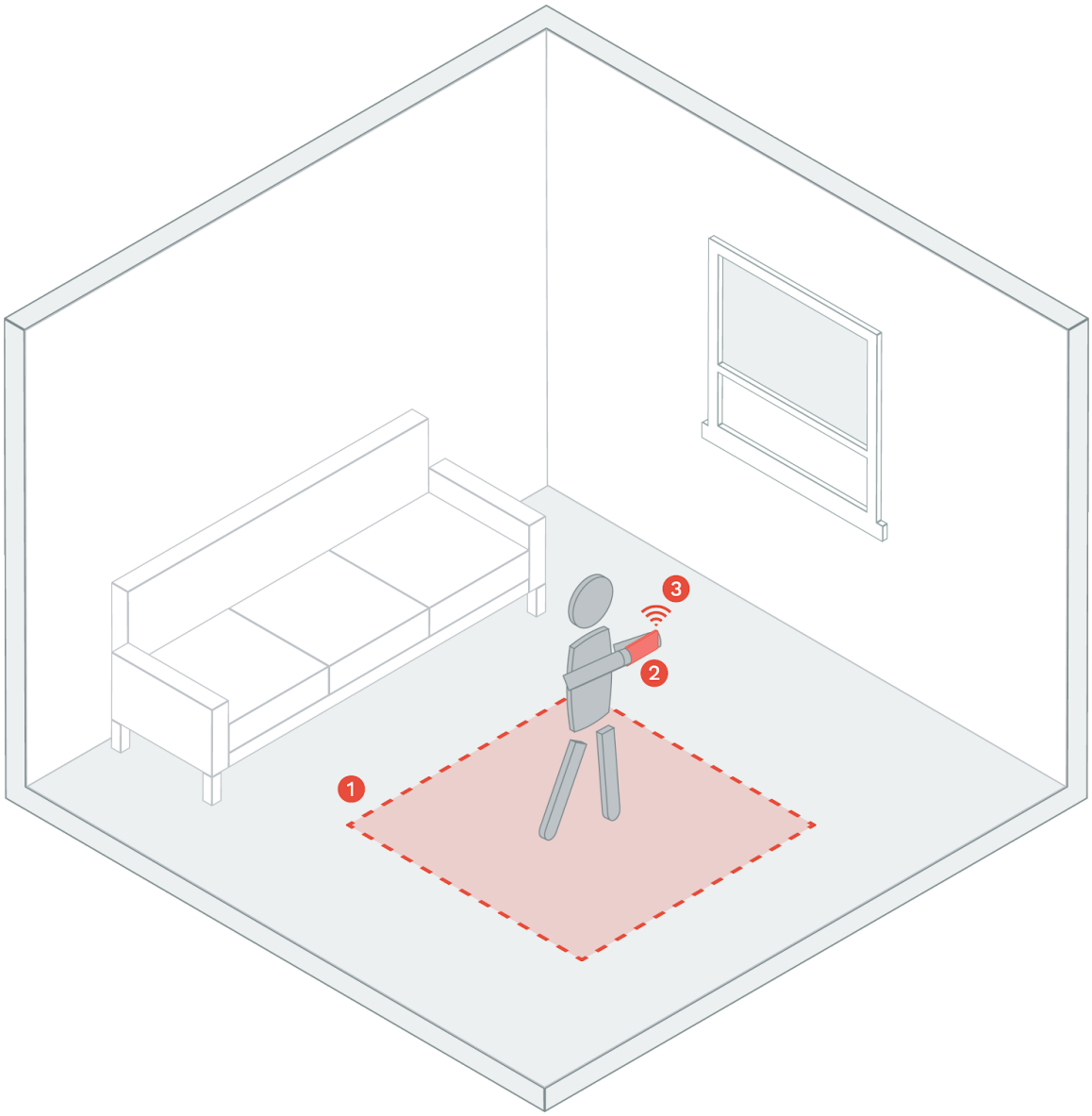


Figure 2.3-2: Physical layout diagram for user playing with a mobile device as the Master

2.4 Design Comps

Please find below the two images outlining the overall design and layout styles that will be applied across the player modes in Kendō Gakkō. A description of the wireframes associated with each of the following design compositions can be found in each figure's caption.

Figure 2.4-1: Design Composition for "Sequence Definition & Send" screen on Mobile

Figure 2.4-2: Design Composition for "Show Sequence" screen in VR (Student perspective)

References

In order of appearance.

[1] Brown, A. (2017, September 11). Who plays video games? Younger men, but many others too. Retrieved January 29, 2019 from http://www.pewresearch.org/fact-tank/2017/09/11/younger-men-play-video-games-but-so-do-a-diverse-group-of-other-americans/

[2] A-Frame – Make WebVR. (n.d.). Retrieved January 26, 2019, from https://aframe.io/

[3] Foundation, N. (n.d.). Retrieved January 26, 2019, from https://nodejs.org/en

[4] Epidemic Sound. (n.d.). Retrieved January 26, 2019, from https://www.epidemicsound.com/

[5] Royalty-Free Music Licensing for Video, Film & YouTube - Artlist.io. (n.d.). Retrieved January 27, 2019, from https://artlist.io/

[6] Oculus - Rift Touch Virtual Reality Headset Bundle for Compatible Windows PCs - Black. (n.d.). Retrieved January 27, 2019, from https://www.bestbuy.com/site/oculus-rift-touch-virtual-reality-headset-bundle-for-compatible-windows-pcs-black/5989502.p?skuId=5989502

[7] Oculus 2-Sensor 360° Experimental Setup. (n.d.). Retrieved January 28, 2019, from https://scontent.fyyz1-1.fna.fbcdn.net/v/t39.2365-6/15397552_232732683816172_4121045365602385920_n.pdf?_nc_cat=101&_nc_ht=scontent.fyyz1-1.fna&oh=136e0d689c04be6790e27fd9dd3b6486&oe=5CFA8F47