Software Requirement Specification for IBM Augmented Reality Quantum with AI

Version 1.0

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Group 26

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Introduction

(1.1) Overview and Justification

Our client, IBM, serves as a prominent corporation within the field of technology. They have a rich history in computing, renowned for their contributions to Quantum Computing. IBM, as represented by John McNamara, has tasked our group to develop a software that teaches the concepts of Quantum Computing to a new, younger audience. The motivation behind this project is rooted in the desire to bridge the gap between the transformative potential of quantum technology and the prevailing perception of it as an elusive and almost science-fictional domain. The goal of the proposed solution is to develop an approachable and educational website that displays an interactive lesson on the fundamentals of quantum computing in an AR environment.

The purpose of our system is to educate High School and University students about quantum technology and direct them towards useful IBM resources to further their learning via IBM SkillsBuild.

The upcoming sections will delve into a comprehensive breakdown of our project, beginning at its Project Scope and System Description. It will move on to build an overview of the requirements of our project as we identify the Functional and Non-Functional Requirements, which are described using EARS (Easy Approach to Requirements Syntax) notation. Building on this, the Risks and Issues associated with the project shall be assessed and a mitigation plan for each risk will be discussed. Finally, we conclude our document with a breakdown of our adopted methodology of Scrum and how we modified it to satisfy team constraints, followed by our Project Schedule.

(1.2) Project Scope

The 'Augmented reality Quantum with Artificial Intelligence' project seeks to offer an appropriate solution to address two challenges:

1. To demystify the largely intangible concept of quantum computing for the public
2. And to develop a creative method to do so.

The proposed software fulfils its purpose in tackling these challenges. The software being an AR application makes the intangible tangible by giving a physical presence to the quantum concepts being explored. This method will increase engagement in our younger audience, making it more interactive and less abstract by putting visuals to the concepts. Our AR solution is creative in doing so, as not many educational platforms have adopted this approach and fully utilised its potential. As described, this solves the problems concerning the unapproachability of quantum computing presented to us by our client, IBM.

The primary stakeholder for this project is IBM, an organisation dedicated to advancing quantum computing awareness and education. The target demographic is primarily a younger audience, specifically high school and university students seeking to enhance their understanding. Should teachers be interested in incorporating quantum computing into their curriculum, they could use this software as an educational tool. Our vision is to create a product that not only simplifies quantum concepts but also serves as an engaging learning resource, encouraging a deeper exploration of the subject.

In addition to the planned implementations, future iterations of the product are envisioned to incorporate enhanced interactivity. We could increase interactivity by incorporating educational mini games, and the software could explore other topics covered by IBM SkillsBuild to create a catalogue of educational content. We could improve how immersive the software is and increase the platforms it is available on by integrating our AR application into Virtual Reality. These additions aim to broaden the scope of topics covered in the initial release, making the product more appealing to a wider audience. This revised version aims to provide more clarity and build on the client's initial desire to improve understanding of the technologies IBM develops.

(1.3) System Description

The product will be an interactive web application accessible through mobile devices. Users will trigger the augmented reality quantum computer model by scanning an image, such as a QR code, instantaneously spawning a 3D model of a quantum computer on their phone screen in their current environment. Watson Text-to-Speech will be employed to provide audible explanations of how quantum computers work, ensuring that those unfamiliar with the subject can grasp the basic concepts. Once these concepts have been explained, there will be an interactive quiz, using IBM's Watson Assistant, to test the user's understanding. The system will conclude by prompting users to enrol in the IBM Introductory Quantum course and allowing them to ask questions via a Watson Assistant chatbot. This will further enhance their knowledge, aligning with the goals of the client.

The proposed system primarily consists of an augmented reality (AR) quantum computer model and a web application. The technical details are as follows:

AR Quantum Computer Model

This will be developed using the Google ARCore (Google ARCore, no date), which will allow us to build a web-based AR application. This has been decided upon after researching alternative solutions, showing that similar foundations such as 'Apple ARKit XR' (Unity Manual, no date) cannot be developed using Windows-based computers and lack the ability to transfer our application over to the web.

Web Application hosted by IBM Cloud

The web application will be the user interface for accessing the AR model and educational resources. It will be designed to be accessible on various devices, although initially developed for Android devices due to the constraints of Google ARCore. This was decided upon as our system should not require any downloads. The web application will be hosted on IBM Cloud, as it has been requested by our client. A con of this is the team currently does not have access to the IBM virtual server, which allows cloud hosting and cloud computing.

IBM Watson Text to Speech

This technology will be integrated into the system to supply spoken explanations of concepts within the AR model. It will enable users to understand complex concepts through auditory means, increasing accessibility.

Watson Assistant

This will be used for the interactive question and answer part, which will allow users to ask questions related to quantum computing and receive responses generated by the previously mentioned Watson Assistant technology. The client asked that Watson be trained using knowledge from the IBM SkillsBuild Quantum Computing Course.

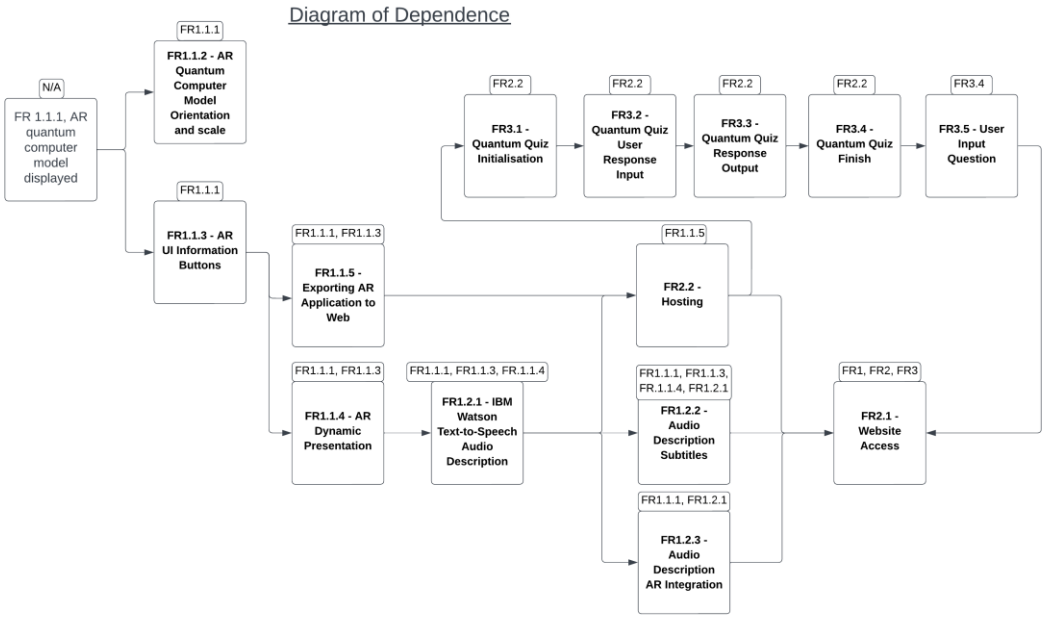
Alternative solutions that have been used for similar educational purposes include:

Alternative Solution	**What is it?**	**Advantages**	**Disadvantages**
zSpace	A premier AR and VR tool in the educational sector. Its immersive learning approach, which lets students interact with augmented reality objects, as though they were tangible, is particularly noteworthy (zSpace, 2023).	By integrating user input through button presses and interactive explanations, we believe this will significantly deepen the comprehension of complex concepts through physical and practical demonstration. Notably, zSpace's flexibility for both in-class and remote use is an aspect we intend to replicate.	zSpace software requires specific hardware and software which costs a lot of money. Our software will be free to use and easily accessible via the web which means it does not require a download.
Prisms VR	An educational technology that primarily employs AR and VR. Prisms VR focuses on teaching abstract concepts like algebra in a 3D environment (Prisms VR, no date).	The interaction of 3D representations of abstract concepts is something we can employ with our 3D model of a quantum computer.	Like zSpace, Prisms VR is also expensive and reliant on specific hardware. Prisms VR is also primarily VR which means a lot of features are not applicable to an AR web application.

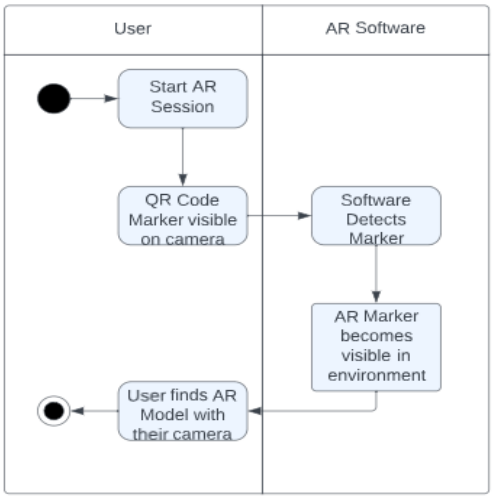
In summary, the client has requested integrations of IBM Watson Assistant and Watson Text-to-Speech. The team has decided to develop the AR Component using Unity and Google ARCore. The client would like the software to conclude with a link to IBM SkillsBuild.

Solution Requirements

(2.1) Functional Requirements

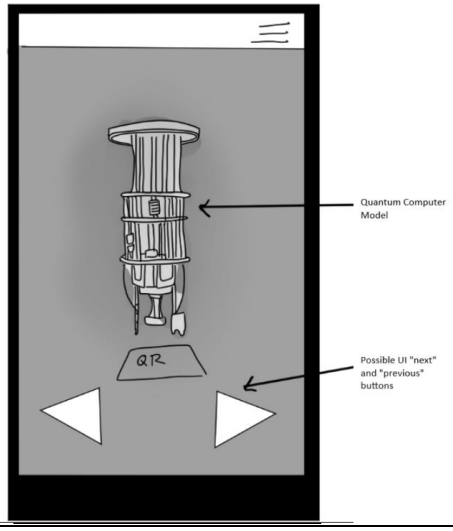


FR1 – AR Quantum Computer Model

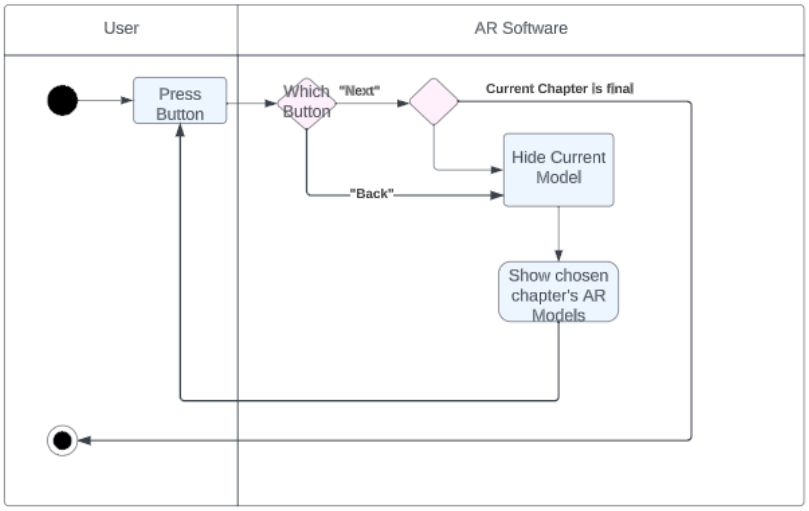
ID and Title	FR1.1.1 - AR Quantum Computer Model Displayed		
Priority	High	**MoSCoW**	Must Have
Description	**Event driven:** *Upon* the user's mobile device detecting a QR code marker, the system *shall* activate and display the AR model of a quantum computer.		
Activity Diagram			
Dependencies	N/A		
Expected results	The correct model *shall* be displayed in a timely manner and in a location intuitive to the user		
Exception handling	*If* the AR Software does not successfully recognise the marker after a set time, an error message *shall* be displayed, and the website *should* direct the user to the quiz and/or SkillsBuild.		

ID and Title	FR1.1.2 - AR Quantum Computer Model Orientation and scale		
Priority	High	**MoSCoW**	Should Have

Description	**State-driven:** *While* the AR Model is displayed, it *should* be oriented and scaled such that it reflects a real-life Quantum Computer.
Dependencies	FR1.1.1
Expected results	The quantum computer model *should* be vertically upright as it would appear in reality. *If* scaling to the real size of the computer is not feasible, the model *should* maintain realistic proportions and the size difference *should* be explained.
Exception handling	*If* the Quantum Computer is spawned in a non-intuitive position, such as upside down or horizontally, that does not reflect reality, the website *should* prompt the user to refresh and re-align the model to the marker.

ID and Title	FR1.1.3 - AR UI Information Buttons		
Priority	High	**MoSCoW**	Should Have
Description	**State-driven:** *While* the AR quantum model is being displayed, interactive buttons *should* also be displayed, allowing the user to interact with the AR environment and model. Buttons *will* include options to go to the next or previous learning 'chapter'.		
Visual Representation			
Dependencies	FR1.1.1		
Expected results	*If* the current working chapter isn't the first one, there *will* only be the option to proceed. Otherwise, the option *should* be to go either to the next or previous section. *If* the current 'chapter' is the final one, the next area shown *should* be a prompt for the quiz section or a link to SkillsBuild (as requested by the client).		
Exception handling	*If* a button is clicked that *should* not perform an action during a certain scenario (e.g. the user clicks the previous button during the first chapter), the *system* will ignore that button's input.		

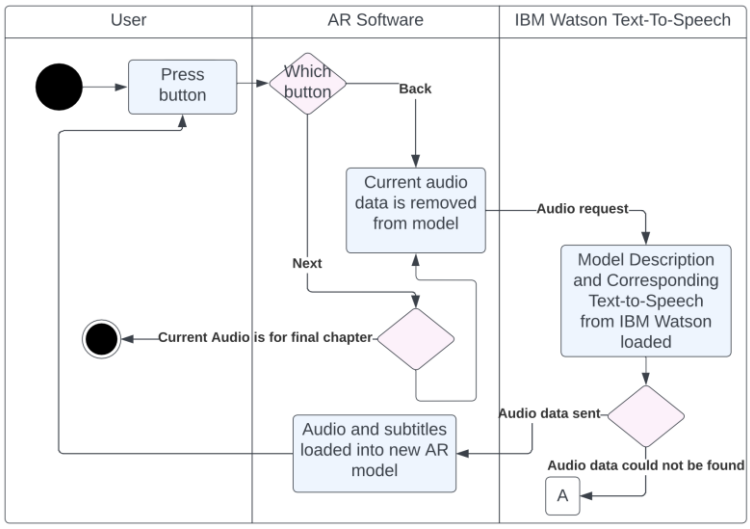
ID and Title	FR1.1.4 - AR Dynamic Presentation		
Priority	High	**MoSCoW**	Must Have
Description	**Event Driven:** *When* a UI Information Button is clicked, the AR Quantum Computer Model *shall* be swapped with a more relevant model (and audio description) for a chosen topic.		

Activity Diagram	
Dependencies	FR1.1.1, FR1.1.3
Expected results	After the button is clicked ('Next' or 'Previous'), the current model being displayed *shall* be replaced by a new model, unless the current 'chapter' displayed is the last in the sequence. Relevant models *shall* include simulations depicting: *Quantum Physics*, *Traditional vs. Quantum Computers*, *how a Quantum Computer Works*, *The Future of Quantum Technology*. A relevant IBM Watson Text-to-Speech audio for the new model *shall* also be output alongside the model. Each model *must* meet the same requirements associated with the main Quantum Model.
Exception handling	*If* the current model being displayed is the final model, the simulation *shall* end and the user *shall* be prompted to either follow a link to IBM SkillsBuild, replay the simulation, or view 'Further Resources'. *If* the UI Information Button is clicked and a new/different model is not displayed, the user will still be able to view the main Quantum Computer model. An error message *must* be printed stating 'Model could not be loaded.'

ID and Title	FR1.1.5 - Exporting AR Application to Web		
Priority	High	**MoSCoW**	Should Have
Description	**Ubiquitous Requirements:** The AR application *shall* be made using Google ARCore technologies such that it can be exported to the website.		
Dependencies	FR1.1.1, FR1.1.3		
Expected results	The expected outcome is the successful creation of an AR application utilising Google ARCore technologies, allowing for seamless exportation to the website. This exportation capability enables users to access and experience the AR application directly through web browsers.		
Exception handling	No specific exception handling procedures are outlined for this requirement. However, it is advisable to implement robust error-checking mechanisms to address potential issues during the exportation process. This may include providing informative error messages and logging functionalities to facilitate troubleshooting in the event of exportation failures.		

FR1.2 - IBM Watson Text-to-Speech

ID and Title	FR1.2.1 - IBM Watson Text-to-Speech Audio Description		
Priority	High	**MoSCoW**	Must Have
Description	**Event-driven:** *When* text is displayed on the screen to describe what is happening, the IBM Watson Text-to-Speech API *shall* be called upon to provide an audio description.		

Activity Diagram	
Dependencies	FR1.1.1, FR1.1.3, FR.1.1.4
Expected Results	Upon user interaction with quantum elements in the AR Quantum Computer Model, the system should seamlessly generate and play corresponding audio descriptions using IBM Watson Text-to-Speech.
Exception Handling	*If* connectivity to the IBM Watson Text-to-Speech API is disrupted, provide a clear error message informing the user of the temporary unavailability of audio description.

ID and Title	FR1.2.2 - Audio Description Subtitles		
Priority	Medium	**MoSCoW**	Could Have
Description	**State Driven:** *While* the audio description of the AR Simulation or its Components is being output, subtitles *should* be displayed along the bottom of the screen.		
Dependencies	FR1.1.1, FR1.1.3, FR.1.1.4, FR1.2.1		
Expected results	Audio output from Watson Text-to-Speech *should* be transcribed at the bottom of the screen in a reasonable font-size and not interfere with the usability of the application. The output rate *should* match the speed at which the audio is output.		
Exception handling	*If* no subtitles are displayed along the bottom of the screen, a box *should* be displayed reading 'Subtitles Not Available'.		

ID and Title	FR1.2.3 - Audio Description AR Integration		
Priority	High	**MoSCoW**	Must Have
Description	**Ubiquitous:** IBM Watson Text-to-Speech and Unity *must* be able to communicate such that, any required audio description is output alongside the correct model. This will require an SDK, such as the Watson Developer Cloud's (Watson Developer Cloud, 2022).		
Dependencies	FR1.1.1, FR1.2.1		
Expected results	*Should* any model require an audio description, the relevant audio will be provided by IBM Watson Text-to-Speech to Unity and Unity *should* be able to use this audio alongside the model.		
Exception handling	*If* IBM Watson and Unity cannot communicate, an error message *must* be displayed stating 'Audio cannot be found'. The relevant quantum model *must* be displayed, even *if* the audio is not available.		

FR2 - Web Application hosted on IBM Cloud

ID and Title	FR2.1 - Website Access		
Priority	High	**MoSCoW**	Must Have
Description	**Event-driven:** *When* a user scans the QR code with a phone's camera, it allows the user to enter the website. The website should also have a unique URL that can be typed if there is no QR Code.		

Dependencies	FR1, FR2, FR3
Expected results	User *should* be able to access the website when they scan the correct QR Code provided, or if they type in the specific URL into the address bar.
Exception handling	N/A

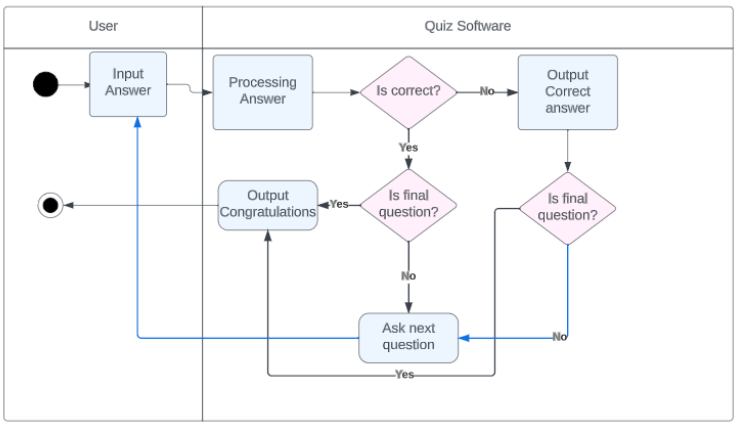
ID and Title	FR2.2 - Hosting		
Priority	High	**MoSCoW**	Must Have
Description	**Ubiquotous:** The web application *shall* be hosted on the IBM Cloud using IBM Virtual hosting/ servers.		
Dependencies	FR2.1, FR1.1.5		
Expected results	The web application *will* be correctly hosted on the IBM cloud and follow expected server behaviours while utilising cloud computing.		
Exception handling	*If* there be any issues with the IBM cloud, the server *should* handle the disruption gracefully displaying useful error messages.		

FR3 – Watson Assistant Technologies

ID and Title	FR3.1 - Quantum Quiz Initialisation		
Priority	Medium	**MoSCoW**	Could Have
Description	**Event-Driven:** *When* a user clicks the start button, the quiz *shall* begin. Questions *will* be generated using the material from 'IBM SkillsBuild Introductory Quantum' course, utilising IBM Watson Assistant and IBM Cloud.		
Dependencies	FR2.1		
Expected results	When a user starts the quiz, the website *shall* publish 5 multiple choice questions sent by IBM Watson Assistant from IBM Cloud. The quiz interface *should* be user-friendly, clear, and accessible.		
Exception handling	*If* the quiz fails to initialize, the website *shall* display an error message and offer a retry option.		

ID and Title	FR3.2 - Quantum Quiz User Input		
Priority	Medium	**MoSCoW**	Could Have
Description	**Event-Driven:** *When* a user interacts with the quiz, the answers selected by the user *shall* be saved and marked for correctness.		
Dependencies	FR2.1,		
Expected results	The website *shall* track and save users' progress of quiz and allow them to resume.		
Exception handling	*If* the UI is not responding, the website *shall* display an error message and allow the user to reload the current page. *If* the user would like to move onto the next question without answering the current question, they *should* be prompted to finish the question before moving onto the next one.		

ID and Title	FR3.3 - Quantum Quiz Response Output		
Priority	Medium	**MoSCoW**	Could Have
Description	**Event-Driven:** IBM Watson Assistant *shall* process the answer, check if the answer is correct, then return the output of whether the user got the question correct. Then, the quiz *will* move onto the next question.		

Activity Diagram	
Dependencies	FR2.1,
Expected results	The website *shall* show the correctness of the quiz question answered by the user and then allow the user to move onto the next question.
Exception handling	*If* IBM Watson Assistant is non-responsive and the correctness of the question is not displayed, the website *shall* display an error message and an option to reload the quiz page.

ID and Title	FR3.4 - Quantum Quiz Finish		
Priority	Medium	**MoSCoW**	Could Have
Description	**Event-Driven:** *When* the user has answered 5 questions generated by the Watson Assistant, the user's final score and feedback *shall* be displayed. The user *shall* be able to either click a button 'Retake' or follow the recommended link to SkillsBuild for more information.		
Dependencies	FR2.1		
Expected results	The user's score and feedback shall be displayed. Two options - 'Retake' and 'SkillsBuild' - shall be displayed. *When* the user clicks the 'Retake' button, the system *shall* reset the quiz. *When* the user clicks the 'SkillsBuild' link, it *shall* direct the user to the appropriate IBM Quantum Computing resources.		
Exception handling	*If* there is a delay in calculating the score and generating the feedback, then there should be a loading indicator to inform the user. *If* the button and link are not accessible, then there should be displayed an option to report the problem and an option to refresh the page.		

ID and Title	FR3.5 - User Input Question		
Priority	High	**MoSCoW**	Should Have
Description	**Event-Driven:** *When* the quiz finishes, the user will be able to ask questions to a chatbot that has been trained by the IBM SkillsBuild Quantum Computing course.		
Dependencies	FR3.4		
Expected results	The chatbot *shall* answer the questions asked by the user correctly and with 90% accuracy.		
Exception handling	*If* there is a delay in generating answers, then there *should* be a sign to inform the user that the chatbot is still generating. *If* IBM Watson Assistant fail to response, then there *should* be displayed an option to report the issue and an option to restart generating.		

(2.2) Non-Functional Requirements

NFR1 – Performance

ID and Title	NFR1.1 – Performance Requirement - Load Times
MosCoW	Should Have
Description	Upon entering the application, the amount of time the user must spend waiting for the application to load should not be excessive to promote user functionality.
Metrics/Fit Criteria	The application must be fully rendered and operational within 1 minute of initiating the loading process. This sets a clear performance standard for the application's loading time. In case of a failure

	the application should distinguish between a server timeout and whether it is related to the system specifications of the user's device. In the latter case, it will suggest to the user to look at the IBM Introductory Quantum Course instead while maintaining to the graphical style of the site.
Security	N/A
Constraints	We do not have control over the user's Wi-Fi speed or if their device's specification is appropriate for loading the app.

ID and Title	NFR1.2 – Performance Requirement – Website Reliability
MoSCoW	Must Have
Description	The website has to offer consistent and reliable access to the user. It is crucial to the positive user experience that the website remains accessible and performs effectively.
Metrics/Fit Criteria	The website fails to load due to a website related issue a maximum of once every 5000 access requests.
Security	N/A
Constraints	We are bound by potential challenges arising from the IBM Cloud services. This constraint stems from the fact that any issues on IBM's end directly impact the performance of our website, subjecting it to the duration required for IBM to resolve the underlying problems.

ID and Title	NFR1.3 - IBM Watson Response Time
MoSCoW	Should Have
Description	Within the Quantum Quiz, When IBM Watson Assistant processes answer, the response should be delivered within 45 seconds
Metrics/Fit Criteria	In the Quantum Quiz, IBM Watson Assistant must process speech and return results within 45 seconds. In the Model Description, IBM Watson Speech-to-Text must describe the model without pause and load audio within 30 seconds.
Security	The processing of speech and the loading of audio by IBM Watson Assistant and Speech-to-Text should adhere to security best practices to ensure the confidentiality and integrity of user interactions and model descriptions.
Constraints	The system should operate within the defined time constraints for speech processing and audio loading specified in the fir criterion. Any delays should be communicated to users with clear messages encouraging patience.

ID and Title	NFR1.4 - IBM Watson Assistant Answers
MoSCoW	Must Have
Description	IBM Watson Assistant must consistently deliver precise and pertinent answers to user queries concerning Quantum Computing.
Metrics/Fit Criteria	Achieve a minimum accuracy rate of 90% in responding to user queries related to Quantum Computing.
Security	Aligns with FR1.2.1 security requirements.
Constraints	Users must receive informative, helpful, and accurate responses to their inquiries, ensuring a positive user experience and effective engagement with Quantum Computing topics.

NFR2 – Security

ID and Title	NFR2.1 – Security Requirement – Code Back Ups
MoSCoW	Must Have
Description	Code will be pushed initially to GitHub. All code from the GitHub Repo will be backed up to a separate cloud location and cloned to all local developer devices at least once per month during all phases of the Software Development Lifecycle. This means that if one location of the code is shut down, we will always have back-ups.
Metrics/Fit Criterion	We will successfully complete this if there are monthly backups that have been committed to a cloud location and that GitHub shows frequent cloning onto local developer devices.

Security	This is an activity that only the developers can do.
Constraints	We will constrain ourselves to the use of GitHub as the primary code repository. We will also exclusively use Google Drive. Finally, we trust the developers to make regular local downloads.

ID and Title	NFR2.2 – Security Requirement – Malicious Attacks
MoSCoW	Could Have
Description	If a malicious attack, website functionality should be restored within 24 hours (using code back-ups). Any reported vulnerabilities should be found and repaired within 2 days. If a malicious attack, communication plan between IBM Cloud will be in place.
Metrics/Fit Criterion	Website restoration within 24 hours of an attack.
Security	We will implement an update and patch management protocol to ensure that when the website is down, we have strict rules to follow to get it back and running and ways to patch the security breach effectively. We will also ensure that only developers can perform these updates and patches.
Constraints	Our primary constraint is that if a malicious attack is launched on IBM and through that attack our security is breached; then the security of our program and any patching is for IBM to accomplish which we cannot guarantee would be done in a timely manner.

ID and Title	NFR2.3 – User Responses to IBM Watson
MoSCoW	Could Have
Description	The user's response to the Quantum Quiz will only be kept until IBM Watson Assistant finishes processing it and the result is recorded. If IBM Watson Assistant does not analyse it successfully, the voice audio recording will be deleted within 5 minutes. The same is true for IBM Assistant when it answers user's questions about Quantum Computing.
Metrics/Fit Criterion	User responses to the Quantum Quiz and questions about Quantum Computing must be retained until successfully processed by IBM Watson Assistant. In cases where processing fails, the corresponding voice audio recording must be promptly deleted within 5 minutes.
Security	To ensure data privacy and security, user responses are securely stored until processed. This approach guarantees accurate tracking of quiz results and Q&A interactions.
Constraints	The retention of user responses is contingent on the successful processing by IBM Watson Assistant. If processing fails, voice audio recordings are subject to immediate deletion within the specified 5-minute timeframe.

NFR3 – Availability and Scalability

ID and Title	NFR3.1 - Scalability Requirement - Application Traffic Scaling
MoSCoW	Could Have
Description	IBM Cloud will be used to host the application and *will* automatically scale the website to be able to cope with varying user traffic and resource requests.
Metrics/Fit Criterion	IBM Cloud will scale the website resources used to cope with user traffic of between 1 and 1000 users at any one time without using any more resources than necessary. If website fails to scale up correctly, website should display useful error messages and keep making requests until website loads. If website fails to scale down, IBM must be notified of failure, as they may attempt to increase hosting costs.
Security	N/A
Constraints	Application *must* not attempt to handle traffic where there are 0 users, as this may lead to application shutting down and an application cold start when traffic grows again (Schweigert and Hadas, 2022).

ID and Title	NFR3.2 – Availability & Scalability Requirement – Website/ AR Access
MoSCoW	Must Have

Description	The objective is to ensure that the website application is accessible and functional across both mobile and tablet devices. This includes ensuring optimal user interface and navigation experiences tailored for a variety of screen sizes, resolutions, and operating systems.
Metrics/Fit Criterion	The measure of success will be the 'as expected' functionality of the website and AR features with major mobile operating systems namely iOS and Android as defined in the functional requirements.
Security	N/A
Constraints	The primary constraints here is that the development and testing will be confined to android and iOS. In addition to this we will have to adhere to the guidelines and best practices set forth by the respective mobile device manufacturers. This includes compliance with any specific standards that these manufacturers advocate that would create an optimal app performance and user experience on their devices.

NFR4 - Technology

ID and Title	NFR4.1 - Technology Requirement - AR Coding
MoSCoW	Should Have
Description	Where code is used for AR components, the code should be written using the software framework Unity (Wikipedia, 2023c) with any custom functions (if needed) written in C# scripts (Unity Documentation, 2018).
Metrics/Fit Criterion	All C# files should have a corresponding edit or config file to maintain standards and no code problems should be displayed within VSCode IDE.
Security	Any C# written for the project shall meet expected Common Code Standards as set out by Microsoft (Microsoft, 2023).
Constraints	All AR component code files committed to GitHub code must have extension '. unity' or '.cs'. If any code used in AR components is not written in Unity or C#, it must be converted by a team member to C# or Unity files with no functionality lost.

ID and Title	NFR4.2- Technology Requirement - Building Website
MoSCoW	Must Have
Description	The main website component (excluding Unity) should be built using HTML, CSS and JavaScript with the option of using REST API (Application Programming Interface) if needed.
Metrics/Fit Criterion	This requirement will be assessed after the completion of the website on whether it has been successfully using HTML, CSS and JavaScript. When testing is conducted, ESLint (Wikipedia, 2023b) developer tool *must* find *no* errors in the JavaScript code and our chosen HTML5 validator (W3C, no date) *must* find *no* issues in the HTML.
Security	The website must not have security exploitable flaws with regards to code.
Constraints	All JavaScript code within the website *must* meet ECMA Standards (ECMA International, 2023) and all HTML within the website *must* meet HTML Living Standard (WHATWG, 2023).

ID and Title	NFR4.3 - Technology Requirement Layout and Uniformity
MoSCoW	Must Have
Description	The website must feature a uniform design, including footers (where relevant), a drop-down menu, and consistent CSS styles. The layout and design should remain constant across all pages.
Metrics/Fit Criterion	The desired consistency in design can be achieved by implementing either Bootstrap or custom CSS. This approach aims to ensure a seamless and visually cohesive user experience. The user experience will be assessed through Google Lighthouse (Chrome for Developers, 2016), serving as a metric for evaluating the effectiveness of the chosen design implementation.
Security	This consistency can be achieved by utilising either Bootstrap or custom CSS, ensuring a seamless and visually cohesive user experience. User experience will be evaluated through Google Lighthouse (Chrome for Developers, 2016).
Constraints	No specific security considerations are outlined for this requirement.

ID and Title	NFR4.4 – Technology – Documents of Application
MoSCoW	Could Have
Description	Postman software can be used to build documentation of all code. This documentation should cover the full range of functionalities offered by the application, supplying clear, detailed, and easily accessible information for developers and users.
Metrics/Fit Criterion	The completeness of the documentation will be assessed by the metric of 90% of the applications functions being clearly described including formats and expected behaviours.
Security	Access to the documentation should be restricted to the developers only, and potentially the client if necessary.
Constraints	The documentation must be created using Postman. It should adhere to industry standards for technical documentation.

(2.3) Risks and Issues

Risk Classification				
Probability →	**Unlikely**	**Possible**	**High Probability**	**Guaranteed**
Greatest Possible Impact ↓				
Minor	Low	Low	Low	Medium
Moderate	Low	Low	Medium	Medium
High	Low	Medium	High	High
Severe	Medium	Medium	High	High

Business

- *Failure to Meet Client Standards*
  - *Risk*: Incorrect software/services or falling behind on practices (e.g. RAG analyses and weekly learning).
  - *Classification*: **Medium** – High Probability/Moderate Impact
  - *Mitigations*:
    - Keep consistent weekly contact with our IBM client.
    - Obtain client preferences on technology.
    - Keep up to date with weekly learning.
- *Failure to Meet Client Requirements*
  - *Risk*: Our product may not function correctly, lack agreed upon features, or not meet performance metrics (e.g. website takes too long to respond to user input)
  - *Classification*: **Medium** – Possible/High Impact
  - *Mitigations*:
    - Create prototypes for early validation.
    - Employ 'fail fast' approach discussed in IBM materials.
    - Prioritise project-critical requirements.
    - Have at least two teammates check and approve a piece of code/project section.
    - Utilise Scrum Methodology benefits – (two weeks (at most) of work is lost if client unhappy with sprint).
- *Change of Client Requirements*
  - *Risk*: Client-requested changes may disrupt planning and development
  - *Classification*: **Low –** Unlikely/Medium Impact

- *Mitigations*:
  - Maintain regular contact with client.
  - Conduct monthly meetings to address changes.
  - Promptly update schedules/specifications.

Project

- *Deadlines and Time Restraints*
  - *Risk:* Learning new technologies within short period will impact code quality.
  - *Classification*: **High** – High Probability/High Impact
  - *Mitigations*:
    - Set team deadlines before academic/client deadlines.
    - Agile principle of sustainable development – do not overwork but work on project consistently.
    - Utilise Kanban board *Code Review* column to ensure code quality is checked.
- *Illness*
  - *Risk:* Teammates will miss weeks due to illness and personal circumstances.
  - *Classification*: **High** – Guaranteed/High Impact.
  - *Mitigations*:
    - Ensure cross-training on all technologies (at least two team members per technology).
    - Communicate with teammates about progress and any issues.
    - Facilitate quick catch-up after recovery.
- *Group Engagement*
  - *Risk:* Difficulty maintaining group momentum and morale through a long project.
  - *Classification*: **Medium** - Guaranteed/Moderate Impact
  - *Mitigations*:
    - Maintain constant communication through thrice-weekly Scrum and meetings.
    - Schedule short breaks from the project for everyone.
    - Encourage mutual support among team members.
- *Testing Failure*
  - *Risk*: Failure of initial tests, especially tests of non-functional requirements.
  - *Classification*: **Medium** - High Probability/Moderate Impact
  - *Mitigations*:
    - Test at regular intervals throughout project development (Use aspects of Test-Driven Development).
    - Code approval from at least two team members.
    - Build in time for fixing code errors, make use of IDE debugging features.

Technical

- *Integration of Code*
  - *Risk*: We are implementing our solution using many different technologies (e.g. IBM Cloud, Unity, Watson) and integrating them will pose a challenging task.
  - *Classification*: **High** - Guaranteed/High Impact
  - *Mitigations*:
    - Test components work together at least once per Scrum sprint (every two weeks).
    - Research/learning should have a focus on integrating technologies (e.g. how to run a Unity application on a website).
- *Reliance on Cloud-based Technology*
  - *Risk:* Cloud-based technologies vulnerable to unpredictable and uncontrollable failure.
  - Classification: **Medium** - Unlikely/Severe Impact
  - *Mitigations*:
    - Introduce functions for graceful disconnects within our code.
    - Reboot the application when the cloud-based tech resumes functioning.
    - Maintain up to date backups of all code.
    - Develop communication plan with IBM for dealing with cloud outages/failures.
- *Security*
  - *Risk*: Our website will be available on the internet and, therefore, vulnerable to malicious attacks that may disable or remove our website.

- *Classification*: **Low** - Unlikely/High Impact
- *Mitigations*:
  - Back up code/website regularly.
  - Perform multiple checks on code security, using IDE tools and specified web-technology validators (NFR4.2).
  - Debug all code for potential vulnerabilities.

Project Development

(3.1) Development Approach

For our method, we have been tasked with using Scrum, even so, we thought researching the advantages of other SDLCs (software development lifecycle) would let us mitigate any disadvantages of Scrum. This way we have a 'best of both worlds' methodology tailored to our needs as students.

Methodology	Why it works? What can we learn from it?	How are we modifying Scrum to mitigate its disadvantages.
Waterfall	Works due to its structured and linear approach, ideal for projects with clear objectives and stable requirements. Teaches the importance of thorough planning and documentation.	Integrating regular review and feedback sessions in Scrum sprints to avoid rigidity. We should revisit earlier phases if needed, rather than strictly following a linear progression as is in the waterfall method.
Rapid Application Development	Effective due to its focus on rapid prototyping, user involvement, and iterative development. Highlights the value of user feedback and flexible design.	Integrating iterative development and regular prototyping within sprints. More frequent client involvement throughout the development process, not just at sprint reviews.
Spiral model	Balances risk management with iterative development. Useful for large, complex, and high-risk projects due to its emphasis on evaluation at each phase.	Integrating risk assessment and management strategies into each sprint. Adopting a more iterative approach while planning and conducting sprints, especially for complex features or components.

For our changes made to Scrum, you can assume anything not mentioned here, especially the artifacts and backlog structure, is following the standard Scrum methodology, as outlined by the official Scrum guide (Schwaber and Sutherland, 2020).

The team consists of six undergraduate students with varying availability, depending on other academic commitments. Because of this, we have decided to drop daily Scrum meetings in favour of Scrum meetings 3 times a week. A factor also contributing to the decision is the lack of a guarantee that the same amount of work would be consistently delivered every day to call for a standup. Scrum meetings would now take place on Monday, Thursday and Friday. This spacing is deliberate as it allows us to discuss and solve problems promptly. It also promotes effectiveness through frequent communication. The team has agreed to actively use the messaging app for enterprises called 'Slack'; this mitigates risks relating to lack of communication further and improves problem response times.

We have decided to settle for a 2-week sprint, as we can safely guarantee that we can complete enough backlog items to warrant a sprint retrospective/sprint review. This arrangement is advantageous for the team due to its inherent flexibility; a member can be unavailable in week 1 of the 2-week sprint but make up for it in the second week. Despite this advantage, we have plans that, as we get more knowledgeable and more efficient with our project due to reviews and such, we will (in term 2) shift to 1-week sprints while maintaining the velocity of the project and supply deliverables to the client at a greater rate.

Sprint reviews, retrospectives and plannings will all be done on Thursdays with project managers as support making it run smoothly. The idea being that at the end of a sprint we will spend half of the meeting reviewing the now-finished sprint incrementally improving efficiency and performance. We will then spend the other half planning the new sprint, we have decided to use the story board point estimation system as that seems much more flexible than the T-shirt style system.

Due to scheduling constraints of our client, we must limit ourselves to communication with the client once a month. We have mitigated the risks of too little client contact through agreeing to be in touch through email whenever we run into problems. No further reasonable mitigation strategies exist that can be applied here.

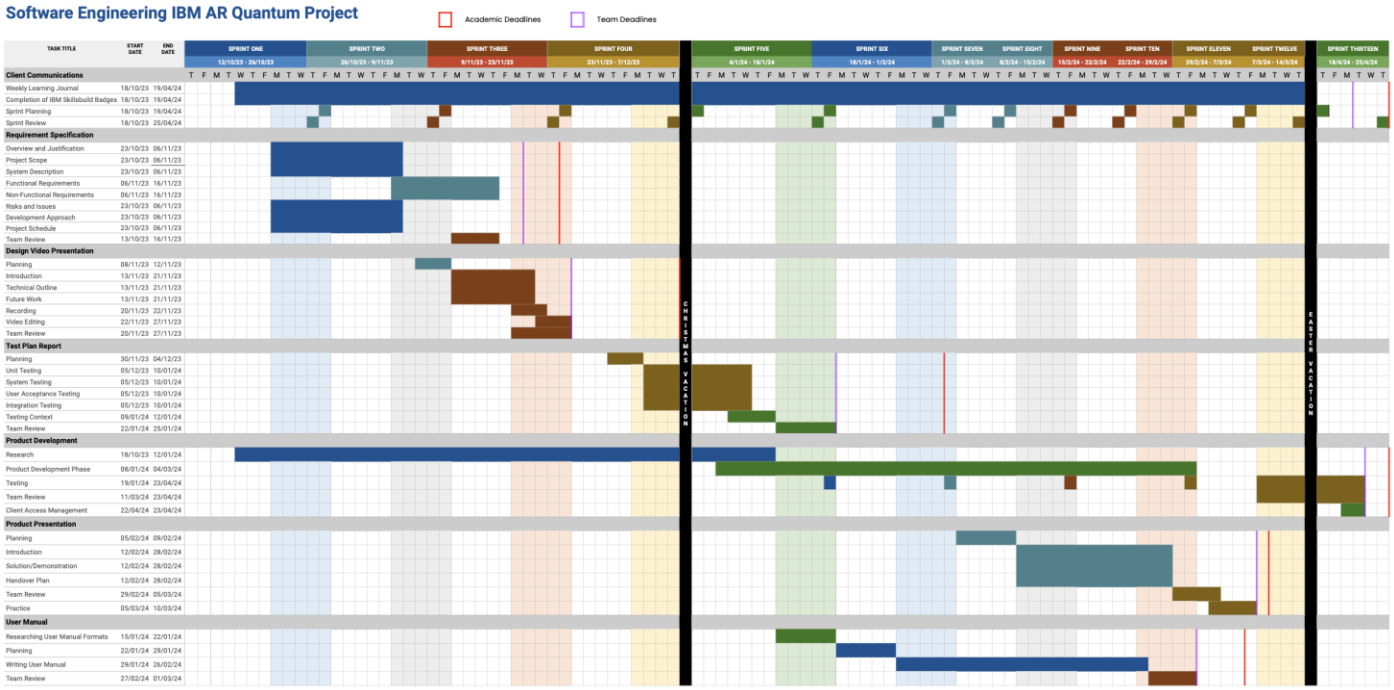
We have decided that the product owner should have the most control over the backlog, meaning their word is final on priorities and what we are working on, however any member of the team can add to the work backlog. This is because we will have specializations on specific features within the project, as such one singular person can't know the technical details of the whole project as that would be an overwhelming amount of work for them given other commitments. We have decided that peer programming would be too time-consuming and would affect the rate at which we can produce deliverables for the client. However, we have decided to have 2 people work on each 'specialization' within the project. So, for instance there will be at least 2 people working on Augmented reality, 2 people working on AI. This works to mitigate the risk of having a problem and not having peer support to refer to, even if we don't plan to have peer programming.

Overall, we believe we have adequately modified Scrum to suit us while eliminating certain disadvantages inherent to Scrum. We feel it is useful to state that our resulting method is not considered 'true' Scrum, as Scrum is fundamentally immutable.

(3.2) Project Schedule

In the Gantt chart below, we highlight both self-imposed and academic deadlines (indicated by lines with different colours and formatted weightings) for the summative aspects of the project. Our self-imposed team deadlines will act as markers for key milestones in the project. During the holidays, the team is not expected to work. This is to keep team morale high and allow team members to rest.

Sprints are an important part of the Scrum methodology, so we have decided to work in two-week sprints during the first term, and one-week sprints after February, as the rate of product development increases. At the client's request, we have arranged to send weekly journals to IBM, taking into account the time to complete them alongside other deadlines. The 'Product Handover' assignment has been included under the larger title of 'Product Development' to align our own product development with the academic assignment. Finally, we have built in planning and review sessions for all major summative assignments, e.g. the 'Test Plan Report', as well as assignment-specific activities, such as video editing for the 'Design Video'. This is to acknowledge the additional tasks that will form part of assignment work and encourage us to look at the time required for each piece of work more realistically. Furthermore, as we progress through product development, we will update and modify this Gantt chart to reflect any unexpected challenges.



To view the Gantt Chart more clearly, we recommend following this link: [Software Engineering Gantt Chart.pdf]

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N.B. All UML diagrams included within this document were created using Lucidchart (https://www.lucidchart.com/pages/).