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PREPARED FOR:
INTEGRATED PROJECT 2025

PROJECT PROPOSAL

SECTION 1 – INTRODUCTION

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I. PROJECT BACKGROUND & OVERVIEW

Rocks & Deepspace is an immersive **Virtual Reality (VR) educational experience** designed for **secondary school students**, centred on the exploration of Mars and the learning of foundational astronomy and planetary science concepts. Leveraging XR technologies, the experience transforms abstract scientific knowledge into hands-on, interactive gameplay, allowing students to actively explore, investigate, and make decisions within a simulated extraterrestrial environment.

In the experience, players take on the role of a robotic rover deployed from Earth to conduct scientific research on Mars. Upon arrival, the rover must first navigate harsh environmental conditions, including Martian dust storms, reinforcing the planet's hostile nature. After stabilising its systems, the rover embarks on its primary mission: scanning terrain, extracting geological samples, and analysing their composition through interactive mini-games.

Unlike traditional quiz-based learning tools, Rocks & Deepspace embeds scientific information directly into gameplay mechanics. Sample analysis occurs immediately after successful extraction, allowing players to understand concepts such as mineral composition and environmental conditions through action rather than passive reading. Collected samples are stored in a limited inventory and can later be displayed within the rover's spaceship hub, visually representing mission progress and discovery.

The application is designed for deployment in controlled educational environments such as **science centres, museums, or school learning-journey venues**, where students can engage with the VR experience under supervision. By situating the experience outside the traditional classroom, the project promotes experiential and play-based learning, demonstrating how immersive technology can enhance student engagement, curiosity, and comprehension of scientific topics.

Game Trailer

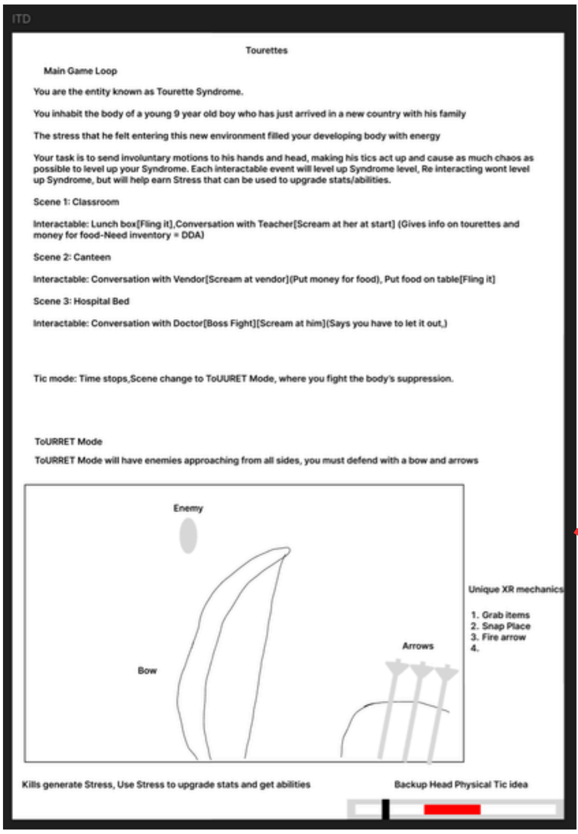
https://www.youtube.com/watch?v=NVLKzwUMOH4

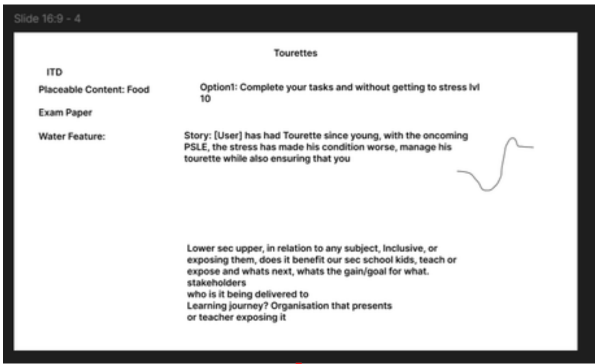
II. DESIGN RATIONALE

The project underwent several stages of ideation before arriving at the final concept, with each iteration contributing important insights into how immersive technology can best support meaningful learning experiences. Early concepts were intentionally exploratory, allowing the team to test different approaches to gameplay, engagement, and educational value before refining the direction of the project.

First Idea

The initial concept focused on creating a game centred around **Tourette Syndrome**, where players experienced the condition from an abstract and metaphorical perspective. While the concept aimed to raise awareness and empathy, the team encountered significant **challenges in translating the idea into engaging and sustainable gameplay mechanics**. The interactions risked becoming repetitive or overly chaotic, and the educational intent was not clearly reinforced through player actions. As a result, the experience lacked a clear progression system and meaningful feedback loop, making it difficult to balance sensitivity, engagement, and learning outcomes.

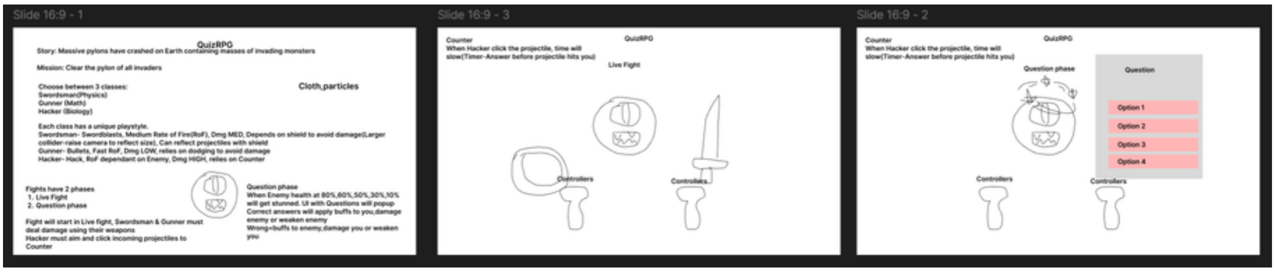




Idea draft for the tourettes game

Second Idea

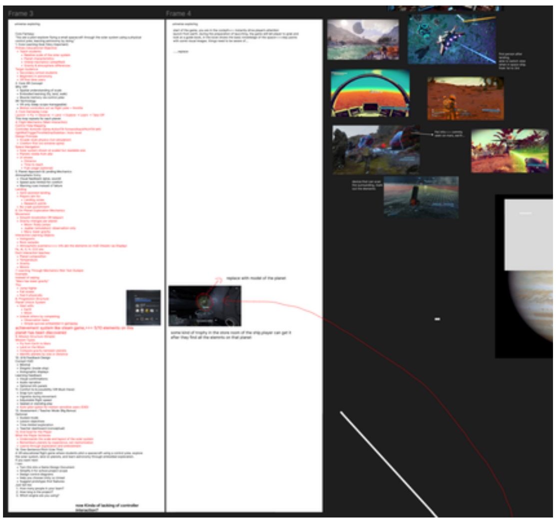
The second concept explored a **Quiz RPG** format designed for primary school students preparing for the PSLE. This iteration incorporated combat mechanics interwoven with question-and-answer segments, where players progressed by answering academic questions correctly. However, through evaluation, the team identified that **this approach relied heavily on direct quizzing rather than experiential learning**. The gameplay primarily tested memorisation and recall, offering limited opportunities for exploration, discovery, or contextual understanding. As such, the experience felt closer to a gamified assessment tool rather than an immersive educational environment, which did not fully match the project objective, which is education.



Idea draft for the Quiz RPG

Third Idea

Building upon the lessons learned from these earlier concepts, the team shifted towards a science-fiction themed VR experience focused on **space exploration**. An early version of this idea emphasised piloting a spacecraft **across the solar system** using cockpit controls, with learning delivered through interface displays and informational panels. While visually engaging, this approach placed heavy cognitive load on players and relied too much on passive information consumption. Educational content risked becoming disconnected from gameplay, reducing immersion and limiting the effectiveness of learning through interaction.



Idea draft
(clear version in annex)

Final Idea

To address these limitations, the final concept reframes the player's role as **a robotic rover exploring Mars directly**. This shift allows learning to emerge organically through player actions such as scanning terrain, extracting rock samples, and interpreting scientific information revealed through the extraction mini-game. Educational content is embedded within gameplay mechanics rather than delivered as standalone text, ensuring that progression and learning are closely linked. By focusing on hands-on exploration, problem-solving, and environmental interaction, the experience better utilises VR's strengths in embodiment and spatial learning.

Overall, the final design reflects a deliberate move away from quiz-based and interface-heavy learning towards an experiential, play-based approach. The Mars exploration concept balances engagement, educational depth, and immersive interaction, while remaining suitable for the target audience and aligned with the project's learning objectives. Importantly, the spaceship hub reinforces learning through application, requiring players to match collected samples to question slots based on the information they uncovered during exploration.

III. HIGH CONCEPT

A VR educational exploration experience for secondary school students where the players play as a robotic rover on Mars, learning astronomy and planetary science through hands-on terrain scanning, sample collection, and in-game feedback.

IV. GOALS & OBJECTIVES

Project Goals

The primary goal of this project is to create an immersive VR educational experience that enables secondary school students to learn astronomy and planetary science through active exploration and interaction. By situating learning within a science-fiction context, the experience aims to increase student engagement, curiosity, and understanding of scientific concepts that are often abstract or difficult to visualise through traditional teaching methods.

Another key goal is to demonstrate the effective use of XR technology as a tool for experiential and play-based learning. The project seeks to move beyond quiz-based or text-heavy educational formats by embedding learning outcomes directly into gameplay mechanics, ensuring that knowledge acquisition occurs naturally as part of the player's actions.

Learning Objectives

Through completing the experience, players should be able to:

- Understand basic characteristics of Mars, including terrain types, environmental conditions, and resource distribution
- Identify the role of robotic rovers in space exploration and scientific research
- Recognise how factors such as terrain, atmosphere, and available resources affect planetary habitability

Experience Objectives

From a user experience and gameplay perspective, the project aims to:

- Encourage learning through exploration, experimentation, and problem-solving rather than memorisation
- Provide clear feedback and progression through visual cues, interactive mechanics, and environmental responses
- Maintain player engagement through varied interactions such as scanning, extraction mini-games, and sample analysis
- Balance challenge and accessibility to ensure the experience remains enjoyable and approachable for secondary school students

Technical & Design Objectives

In alignment with XR design principles, the project also aims to:

- Leverage VR’s strengths in spatial awareness and embodiment to enhance understanding of scale and environment
- Integrate educational content seamlessly into gameplay mechanics rather than relying on standalone information panels
- Ensure the experience is suitable for deployment in supervised educational spaces, with consideration for comfort, safety, and usability

V. TARGET PLATFORM / AUDIENCE

Target Platform

The experience is designed for **Virtual Reality (VR) head-mounted displays**, with intended deployment in **controlled educational environments** such as the Science Centre Singapore, science museums, or similar informal learning institutions. These venues are commonly used for school learning journeys and provide the necessary infrastructure, supervision, and spatial control required for safe and effective VR experiences.

Singapore Science Centre, in particular, is an appropriate proposed deployment context due to its focus on interactive science education and its existing use of hands-on exhibits to support experiential learning. Implementing the VR experience in such an environment allows the project to complement physical exhibits with immersive digital interaction, enhancing students' understanding of astronomy and planetary science beyond traditional classroom settings.

By situating the experience within supervised institutional spaces rather than unsupervised home use, the project ensures better management of equipment, physical safety, and user comfort, while maximising the educational value and accessibility of immersive technology.

Reference image of an astronomy exhibition space at Science Centre Singapore

This environment demonstrates how immersive visuals and hands-on scientific instruments are used to engage students in learning about space. A similar astronomy-focused zone could serve as a potential deployment area for the proposed VR experience, allowing students to explore planetary science as part of a supervised learning journey or open house programme.

Target Audience

The target audience for this project is **secondary school students**, with a **primary focus on lower secondary students (Secondary 1–2)**. This audience was selected based on their cognitive readiness, familiarity with digital technologies, and suitability for immersive learning experiences using VR hardware.

Lower secondary students are at a formative stage of learning where foundational scientific concepts, including topics related to space, planets, and environmental systems, are introduced and developed. Presenting these concepts through an interactive Mars exploration experience allows students to visualise and contextualise abstract ideas such as planetary terrain, atmospheric conditions, and habitability. The experience is designed to support conceptual understanding and curiosity-driven learning, making it particularly suitable for Secondary 1–2 students.

Upper secondary students (Secondary 3–4) are also considered part of the target audience, as the experience can function as an enrichment or exploratory learning tool beyond the core curriculum. However, due to increased academic demands and examination preparation the primary design focus remains on lower secondary students. A shorter, exploratory learning experience is more likely to align with the schedules and attention spans of lower secondary students, particularly within informal learning contexts such as school learning journeys.

Primary school students were considered during early ideation but were not selected as the main audience due to practical and usability considerations. Younger students may be less accustomed to VR equipment and more susceptible to discomfort or improper handling of head-mounted displays. In contrast, secondary school students are more likely to follow usage guidelines, understand safety instructions, and engage meaningfully with the learning content presented in VR.

VI. UNIQUE SELLING POINTS

Learning Through Embodied Exploration

Unlike traditional educational tools that rely on text, videos, or quizzes, the experience allows students to **embody a robotic rover on Mars**. Learning occurs through physical actions such as scanning terrain, extracting samples, and navigating the environment, reinforcing scientific concepts through embodied and spatial interaction rather than passive information consumption.

Educational Content Embedded Into Gameplay Mechanics

Scientific knowledge is unlocked through gameplay performance rather than presented as standalone text or assessments. The element extraction mini-game determines the depth of information revealed based on sample purity, encouraging careful interaction and exploration. This design ensures that learning progression is directly tied to player actions, making education an integral part of the experience rather than an interruption.

Designed for Informal Learning Environments

The experience is specifically designed for deployment in **science centres and educational learning-journey venues**, rather than home use. This allows the project to align with informal education settings, complementing physical exhibits with immersive digital interaction. The structure supports short, guided play sessions suitable for group visits, open houses, and supervised educational programmes.

Inclusive, Low-Physical-Demand VR Interaction

Unlike many VR experiences that require large physical play areas or full-body movement, this project is designed to function within a **compact, stationary play space**. Player movement is controlled primarily through handheld controllers, with interactions focused on hand and arm-based actions such as scanning, swiping, and selecting. This design allows students with limited mobility, including wheelchair users, to participate comfortably, supporting inclusive access to immersive learning experiences.

Scalable Concept for Future Expansion

While the current experience focuses on Mars to ensure depth and feasibility within the project timeline, the core design is scalable. The structure of exploration, scanning, and analysis can be extended to other planets or celestial bodies in future iterations, allowing the experience to grow into a broader astronomy learning platform beyond the initial scope.

Purpose-Built for XR Strengths

The project leverages VR’s strengths in spatial awareness, scale perception, and immersion, which are particularly effective for teaching astronomy and planetary science. Concepts such as terrain variation, environmental conditions, and planetary habitability are conveyed through direct interaction with the environment, offering learning affordances that are difficult to achieve through traditional media.

SECTION 2 – GAME DESIGN DOCUMENT

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I. GAME OVERVIEW

Rocks & Deepspace is a single-player Virtual Reality (VR) educational exploration game set on Mars. **Players take on the role of a robotic rover deployed from Earth to conduct geological research in a hostile extraterrestrial environment.** The experience is designed as one continuous exploratory journey that integrates learning directly into player actions, minimising text-heavy instruction and focusing on hands-on discovery.

The game begins with the rover caught in a Martian dust storm. Visibility is progressively reduced as dust accumulates on the player's view, prompting players to locate a nearby shelter. Once safe, players use arm- and hand-based wiping gestures to clear the rover's sensors and perform basic repairs, introducing core XR interactions through an intuitive onboarding sequence before the main mission begins.

After onboarding, players explore the Martian terrain to collect five types of rock samples. Using an integrated scanning-and-extraction tool, players locate sample-bearing rocks and trigger a short calibration mini-game. Performance in the mini-game determines how much scientific information is revealed about the rock, meaning that higher accuracy unlocks clearer clues for later decision-making.

Collected samples are stored in a limited 6-slot inventory and returned to the spaceship, which functions as the game's progression hub. Inside the spaceship are five display slots, each paired with a science question based on information obtained during sample extraction. Players must place the correct rock sample into the correct slot. Correct placements cause the slot to glow, while incorrect placements destroy the sample, requiring the player to return to the surface and recollect that rock type.

The mission is completed when all five samples are correctly placed and illuminated. The experience concludes with a narrative ending where the rover transmits its Mars exploration and analysis report back to Earth before entering dormancy mode, reinforcing a clear sense of closure and achievement.

II. PLATFORM MINIMUM REQUIREMENTS

Hardware Requirements

- VR Headset:
    - Meta Quest 2 or equivalent standalone VR headset
- Controllers:
    - Two handheld VR controllers with positional tracking
- (Required for scanning, drilling, wiping, repairing, and navigation)
- Tracking System:
    - Inside-out tracking supported by the headset
    - No external sensors required
- Play Space:
    - Small, stationary play area suitable for seated or standing use (Approximately 1.5m × 1.5m or larger)

Software Requirements

- Operating System:
    - Meta Quest system software compatible with Unity-built VR applications
- Application Platform:
    - Standalone VR application deployed directly to the headset
    - No PC tethering required

Performance & Comfort Considerations

- Stable frame rate to reduce motion discomfort
- Optimised 3D assets, lighting, and particle effects to suit standalone hardware limitations
- Clear visual contrast and readable UI elements to ensure visibility within the headset

User Requirements

- Ability to hold and operate handheld controllers
- Ability to perform basic hand and arm movements for interaction
- Experience is fully playable while seated, with no requirement for physical walking or leg movement

III. SYNOPSIS

In Rocks & Deepspace, the player awakens as an Earth-deployed robotic rover on the surface of Mars, immediately caught in a violent dust storm. With visibility rapidly collapsing, the rover must race to shelter to prevent mission failure. Once safe, the rover clears dust from its sensors and stabilises its damaged systems, preparing to begin its scientific objective.

With communication from Earth restored, the rover is tasked to explore the Martian terrain and collect five key rock samples needed to complete an analysis report on Mars' environment. Using its integrated scanning and extraction tool, the rover identifies sample-bearing rocks and performs a calibration procedure to extract usable specimens. The quality of the extraction determines how much scientific information is revealed, meaning careful and accurate work directly supports better understanding and decision-making.

As samples are collected, the rover returns to its spaceship hub, where each storage slot is linked to a scientific question. The rover must match each sample to the correct slot based on the clues it uncovered during extraction. Correct samples activate the slots and illuminate the display, while mistakes destroy the sample, forcing the rover to return to the surface and try again.

When all five samples are correctly placed and the ship's display is fully lit, the rover compiles its findings and transmits the completed report back to Earth. With its mission fulfilled, the rover enters dormancy mode, awaiting future reactivation.

IV. GAME RULES

Objectives & Win Condition

- The player must collect 5 specific rock samples from the Mars environment.
- The player must place each sample into the correct spaceship slot based on the question shown at that slot.
- The game is completed when all 5 slots are correctly filled and glowing.

Loss / Failure Conditions

- The game does not have a traditional “game over” state. Instead, failure occurs as progress loss:
  - If a player places a sample into the wrong slot, the sample is destroyed (explodes).
  - The player must return to Mars and recollect that rock type again to retry.

Sample Collection Rules

- Samples can only be collected after the player:
  a. Scans to locate a valid sample-bearing rock
  b. Extracts the sample by drilling
  c. Completes the mini-game
- Sample information revealed depends on mini-game performance:
  - Higher performance unlocks more accurate and complete information
  - Lower performance provides limited clues, making slot-matching harder

Inventory Rules

- Samples can only be collected after the player:
  a. Scans to locate a valid sample-bearing rock
  b. Extracts the sample by drilling
  c. Completes the mini-game
- Sample information revealed depends on mini-game performance:
  - Higher performance unlocks more accurate and complete information
  - Lower performance provides limited clues, making slot-matching harder

Damage / Repair Rules

- The game does not use a traditional HP bar.
- Player damage is represented visually through sparks on the rover’s arm:
  - No sparks = fully functional / healthy
  - More sparks = higher damage severity
- Damage can be caused by:
  - Prolonged exposure to dust storm zones
  - Stepping on thermal vents

Damage / Repair Rules (cont.)

- To recover, the player must use the wrench repair tool:
  - Repairing reduces sparks gradually
  - The rover is considered fully repaired when sparks disappear completely

Failure Implication (No "Death")

- The player does not "die" or get a game over.
- Damage acts as a pressure mechanic that encourages players to:
  - avoid hazards
  - repair themselves before continuing exploration efficiently

V. GAME STRUCTURE

Phase 1: Onboarding (Storm → Shelter)

- Player spawns in a dust storm and must locate shelter.
- Under shelter, the player learns:
  - Wiping to clear dust from sensors (dirty state)
  - Repairing using the wrench when damage occurs
- Repairs are communicated through the sparks system:
  - Sparks indicate rover damage
  - Repairing removes sparks until the rover is stabilised

Phase 2: Exploration & Collection (Mars Surface)

- Player explores the Mars terrain to locate rock samples
- Core loop:
  a. Scan to locate sample-bearing rocks
  b. Drill to initiate extraction
  c. Play mini-game to determine extraction success/info quality
  d. Receive instant analysis info
  e. Store sample in inventory (6 slots)
- Hazards (thermal vents / storm zones) introduce risk.
  - When hazards cause damage, sparks appear and intensify, prompting the player to repair. This keeps the focus on environmental awareness without requiring a numeric health UI.

Phase 3: Knowledge Application (Spaceship Hub)

- The spaceship functions as a progression hub.
- Inside are 5 sample slots, each paired with a question.
- Player places samples from inventory into slots:
  - Correct sample → slot glows (progress saved)
  - Wrong sample → sample destroyed → must recollect and retry

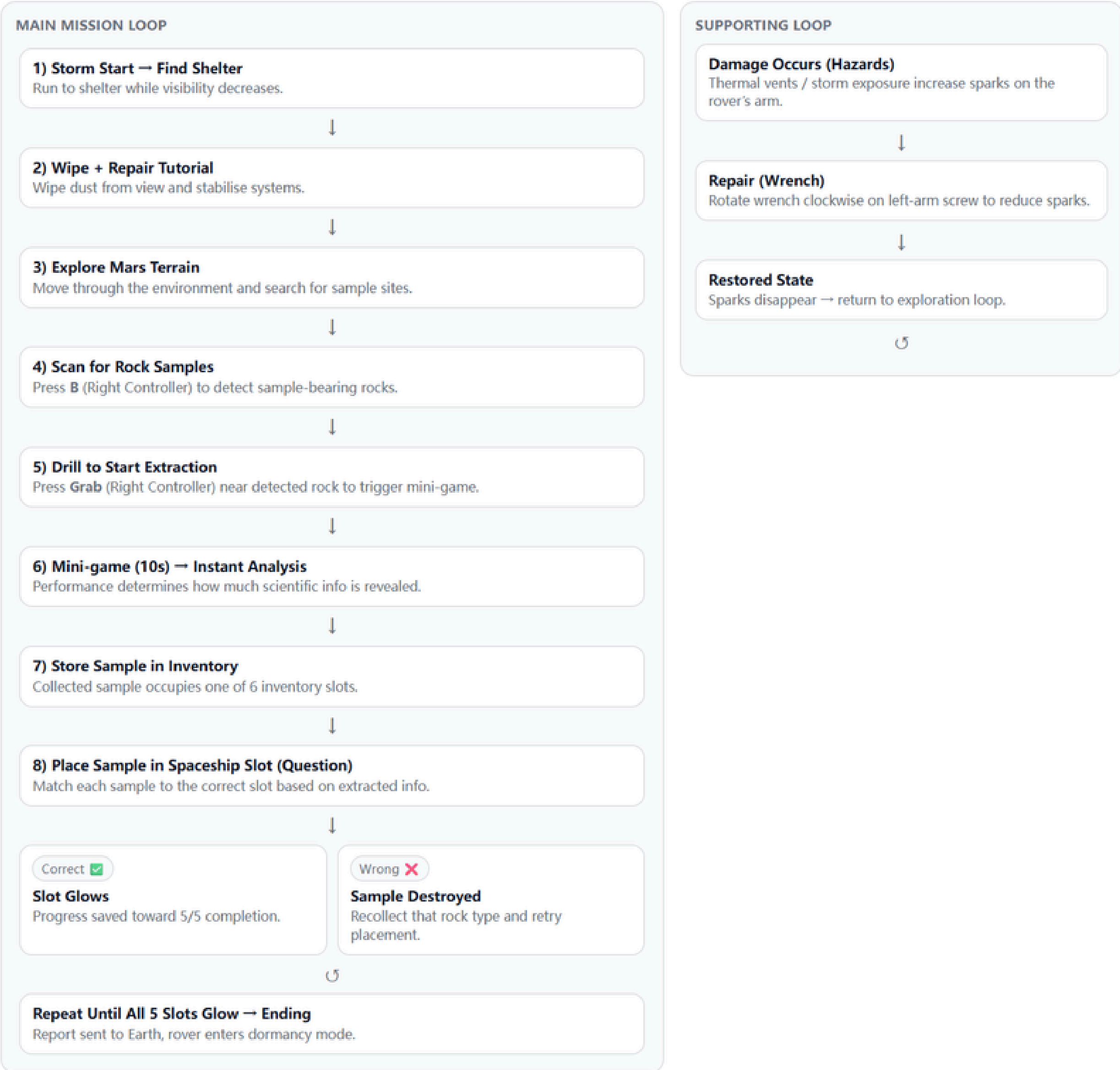
Phase 4: Completion & Ending

- When all 5 slots glow:
  - Mission is marked complete
  - Ending scene plays: rover sends Mars exploration and analysis report to Earth
  - Rover enters dormancy mode

VI. CORE GAMEPLAY LOOP

Core Gameplay Loop – Rocks & Deepspace

Single-level loop (Main Mission) + Supporting loop (Damage → Repair). Inventory: 6 slots. Goal: fill 5 spaceship slots correctly.



VII. GAME CONTROLS

Category	Action	Control / Input	In-Game Result
Movement	Move (locomotion)	Left joystick (Left controller)	Player moves around the Mars terrain
	Turn	Right joystick (Right controller)	Player rotates view direction
Extractor (Scanner + Drill)	Scan for rock samples	**B button** (Right controller)	Highlights/detects sample-bearing rocks
	Drill / start extraction	**Grab** (Right controller) near detected rock	Triggers the 10-second mini-game and extraction process
Wiper	Clean dust from view	Hand wiping gesture across view	Dust overlay clears, visibility restored
Wrench	Repair damage	Rotate wrench **clockwise** on left-arm screw	Reduces sparks until fully repaired (no sparks)
Inventory	Store collected samples	Manual pickup after extraction (Grab + store)	Sample placed into 1 of 6 inventory slots
Spaceship	Place sample into slot	Bring sample to slot and release (snap placement)	Correct: slot glows Wrong: sample destroyed

VIII. PLAYER

Player Character

The player assumes the role of **a robotic rover deployed from Earth** to conduct scientific exploration on Mars. The rover is designed as a non-human character to avoid assumptions about human physical abilities and to support inclusive interaction design(**Avoid stereotypes**).
The rover is equipped with built-in tools that allow it to scan the environment, extract geological samples, perform self-repairs, and survive hazardous Martian conditions. The player experiences the game from a first-person perspective, reinforcing immersion and the feeling of embodiment as a robotic explorer rather than a human character.

Player Metrics

The player character is governed by a small set of core metrics that provide feedback on system status and progression:

- Damage Severity (Sparks): Represents the rover's system damage through a diegetic visual indicator. When the rover is exposed to hazards such as thermal vents or dust storms, sparks appear and intensify on the rover's arm. When fully repaired, sparks disappear completely, indicating the rover has returned to a stable condition.

- Inventory Capacity (6 Slots): Represents the number of sample slots available to store collected rock samples. Inventory capacity is limited to encourage decision-making around what to carry back to the spaceship hub.

- Mission Progress: Tracked through the number of correct samples successfully placed into the spaceship display slots. Progress is visually reinforced through each slot glowing when the correct rock sample is inserted.

Player States

The player character can exist in several states that influence gameplay and interaction:

- Normal State: The rover is fully operational with clear vision. The player can explore, scan, extract samples, and interact with the environment.

- Dirty State (Obstructed Vision): Triggered when the rover is exposed to dust storms. Dust accumulates on the rover's visual sensors, reducing visibility. The player must use the wiper to clean the screen and restore visual clarity.

- Damaged State (Sparks Active): Triggered when the rover takes damage from hazards such as thermal vents or storm exposure. Sparks appear on the rover's arm as a visual warning. The player can recover by using the wrench to repair until sparks are cleared.

- Sheltered State: Occurs when the rover is within a safe zone such as a shelter. Hazard effects are reduced, allowing the player to wipe dust, repair damage, and receive tutorial guidance without immediate environmental pressure.

Weapons / Tools

The game does not feature traditional weapons or combat mechanics. Instead, the player is equipped with functional tools designed for exploration and survival:

- Extractor (Scanner + Drill): A combined tool used to locate and extract rock samples. The scanner is activated using the B button (right controller). When a sample-bearing rock is detected, the player uses Grab (right controller) to drill and trigger the extraction mini-game.

- Wiper: Used to clean dust and debris from the rover's visual sensors. The player performs a wiping motion across their view to restore visibility during or after dust storms.

- Wrench: A repair tool used to stabilise the rover after taking damage. The player rotates the wrench clockwise on the rover's arm to reduce sparks until the system is fully repaired.

These tools emphasise non-violent, hands-on interaction, reinforcing the educational focus of the game while supporting intuitive VR mechanics.

IX. CHARACTER LINE-UP

The experience features a single playable character — an autonomous robotic rover. No additional characters or NPCs are present, as the gameplay focuses on environmental exploration and interaction.

X. LEVEL DESIGN & SETTING

Rocks & Deepspace is designed as a single-level VR experience set on Mars. Rather than using multiple stages or separate levels, the game takes place in one continuous environment that supports free exploration and clear progression within a contained scope.

Setting

The setting consists of two primary spaces:

1. Martian Surface (Exploration Zone)
The main playable area where players navigate terrain, locate rock samples, and interact with hazards. The environment is designed to communicate Mars as a hostile landscape through elements such as dust storms, low visibility moments, and thermal vents.

2. Spaceship Hub (Progression Zone)
A contained indoor area used for mission progress and completion. The spaceship includes five sample slots, each paired with a question prompt. Players return here to place collected samples into the correct slots, turning exploration knowledge into applied decision-making.

Setting

The level is organised into a simple progression flow:

- Onboarding Route: Storm start → shelter area (wiping + repair tutorial)
- Main Exploration Route: open terrain with sample sites and hazards
- Return Loop: player visits the spaceship hub multiple times to place samples and check progress

Design Intent

The single-level structure supports:

- A clear and cohesive learning journey without unnecessary complexity
- Player freedom to explore at their own pace
- Repeated cycles of exploration and return, reinforcing memory and understanding through interaction

XI. MVP (MINIMUM VIABLE PRODUCT)

The Minimum Viable Product (MVP) for this project focuses on delivering the core educational and interactive VR experience while maintaining a realistic scope within the project timeline and technical constraints. The MVP demonstrates the fundamental gameplay loop, key XR interactions, and learning outcomes without implementing future expansions.

MVP Core Features

1. Core Environment

- A single playable Mars terrain environment
- One functional shelter area for onboarding and safety
- One spaceship hub used for sample placement and mission completion

2. Player Mechanics

- First-person VR control of a robotic rover
- Controller-based locomotion suitable for seated play
- Diegetic damage feedback using a sparks system (no numeric HP bar)

3. XR Interaction Tools

- Extractor (Scanner + Drill):
  - Scan minerals using the B button
  - Drill detected rocks using the grab input to trigger a mini-game
- Wiper:
  - Hand-based wiping gesture to clear dust from the screen
- Wrench:
  - Repair interaction to reduce/clear sparks on the rover's arm

4. Hazards

- Sandstorm at the start of the game (and optional designated areas) that reduces visibility
- Thermal vents that cause system damage (sparks intensify) when stepped on

5. Sample Collection & Learning

- Five collectible rock sample types (project-defined)
- A short calibration mini-game that determines how much information is revealed
- Immediate analysis feedback shown after extraction
- A manual pickup system where samples spawn physically and must be collected by hand
- Inventory system with 6 limited slots

6. Progression & Completion

- Spaceship hub contains 5 display slots, each paired with a science question
- Players must match the correct sample to the correct slot based on information learned
- Correct placement causes the slot to glow
- Wrong placement causes the sample to be destroyed, requiring recollection
- Mission completes when all 5 slots are correctly filled and the ending sequence plays

Excluded from MVP (Future Scope)

The following features are intentionally excluded from the MVP to control scope and ensure stability:

- Multiple planets or environments
- Advanced narrative branching
- Multiplayer or cooperative gameplay
- Adaptive difficulty systems
- High-fidelity environmental simulation

These features may be considered for future iterations if additional time and resources are available.

XII. WISHLIST

The Wishlist outlines features and enhancements that are not included in the MVP but would significantly improve the experience if additional time, resources, or technical support were available. These items represent potential directions for future development rather than confirmed deliverables.

1. Additional Planets and Environments

Expand the experience beyond Mars to include other celestial bodies. Each environment could introduce unique hazards, terrain types, and scientific learning objectives, increasing replay value and educational depth.

2. Expanded Sample Types and Deeper Analysis

Introduce a wider variety of geological samples with more detailed scientific analysis, including comparisons between elements and environmental conditions to support more advanced learning outcomes.

3. Enhanced Visual and Environmental Effects

Improve visual fidelity with more dynamic lighting, refined particle effects, and additional weather variations, while maintaining comfort and performance on standalone VR hardware.

4. Adaptive Guidance and Learning Support

Implement contextual hints or adaptive guidance that responds to player behaviour, supporting first-time VR users without disrupting experienced players.

5. Alternative Interaction Methods

Support additional interaction options such as simplified one-handed controls or gesture-based input to further improve accessibility for users with different physical abilities.

6. Multi-language Support

Introduce support for multiple languages to accommodate students from different linguistic backgrounds. This would be especially beneficial in educational and public settings, allowing the experience to be more inclusive and accessible to a wider audience.

7. Enhanced Mini-game Design

Refine the sample extraction mini-game by introducing greater variation or alternative mechanics that better reflect scientific processes. This could include multiple extraction techniques, pattern recognition challenges, or decision-based interactions that deepen engagement while maintaining clarity and ease of use.

SECTION 3 – UX DOCUMENTATION

TABLE OF CONTENTS

I. USER PERSONA

NAME	Fion Loh Li Ting
AGE:	13 years old
OCCUPATION:	Student
SCHOOL:	Yishun Town Secondary School

USER DESCRIPTION:
Fion Loh Li Ting is a Secondary 3 student who enjoys science and space-related topics. She is curious about how planets form and how technology is used in space exploration. Fion enjoys interactive learning experiences, especially those that allow her to explore environments visually rather than relying heavily on text. Fion wears glasses for short-sightedness. While she is comfortable using digital devices, she sometimes finds immersive experiences challenging if visual elements are too small or unclear. She prefers interfaces with clear visuals, strong contrast, and minimal text.

PERSONAL CHARACTERISTICS:	HOBBIES AND INTERESTS:
• Curious and observant • Enjoys visual and hands-on learning • Patient when exploring new environments	• Learning about space and astronomy • Visiting science centres and museums • Playing casual exploration-based games
GOALS:	CHALLENGES:
• To understand planetary science in an engaging and immersive way • To enjoy VR experiences without visual strain • To participate confidently in school learning journeys	• Wears glasses, which may be uncomfortable in some VR headsets • Difficulty reading small text or low-contrast UI in immersive environments • Experiences mild visual fatigue when interfaces are cluttered or unclear
NEEDS:	SOURCES OF INFO:
• Large, readable UI elements and icons • High-contrast visuals instead of small text • Clear spatial cues and visual feedback for interaction	• School science lessons • Science Centre visits • Educational videos and documentaries

II. USER JOURNEY

1) Arrival & Setup — Pre-experience

Curious · Slightly unsure

CONTEXT
Ryan arrives with classmates during a learning journey and approaches a supervised VR station in the astronomy area.

TOUCHPOINTS
- Staff helps fit headset while Ryan stays seated
- Quick controller briefing + safety boundary reminder

PAIN POINTS
Worries some VR experiences require standing or large movement.

DESIGN RESPONSE
Seated-first setup, clear "play seated" indicator, simple controls.

2) Storm Onboarding — Tutorial by scenario

Immersed · Focused

CONTEXT
The rover is caught in a dust storm. Visibility decreases as dust builds up on the "sensor view".

ACTIONS
- Use controller locomotion to find shelter
- Once sheltered, wipe dust using arm/hand gestures

FEEDBACK
Dust clears progressively, restoring vision. Audio/visual cues confirm safety.

INCLUSIVE NOTE
All interactions doable seated; no leg movement needed.

3) Mission Brief + Repairs — Orientation

Confident · Clear

CONTEXT
After cleaning the view, Ryan receives a task list and returns to the spaceship for repairs.

TOUCHPOINTS
- Short, icon-based objectives
- Simple repair interaction (e.g., battery swap)

PAIN POINTS
Too much text or complex menus can overwhelm first-time VR users.

DESIGN RESPONSE
Diegetic UI (in-world panels), minimal reading, clear "next step" cues.

4) Exploration + Scan — Main learning phase

Curious · Learning

CONTEXT
Ryan navigates the Mars terrain looking for points of scientific interest.

ACTIONS
- Use shoulder scanner to detect elements
- Approach detected rock/area

FEEDBACK
Scanner highlights targets with icons + shape cues (not colour-only).

INCLUSIVE NOTE
Compact movement + controller locomotion supports wheelchair users.

5) Extraction Mini-game + Instant Analysis — Reward & learning

Engaged · Rewarded

CONTEXT
Ryan extracts the element via a short calibration-style mini-game.

SYSTEM RULES
- Performance affects purity
- Higher purity reveals deeper info

LEARNING OUTPUT
Element info appears immediately after success (no lab return needed).

DESIGN RESPONSE
Information is tied to action, reducing "quiz feel" and improving retention.

6) Trophy Placement + Completion — Progress closure

Proud · Satisfied

CONTEXT
Ryan returns to the spaceship hub to place collected samples in display slots.

ACTIONS
- Snap/place samples into designated display areas
- Displays glow as collection fills up

OUTCOME
Visual completion reinforces achievement; mission ends with dormancy sequence.

POST-EXPERIENCE
Ryan discusses what he learned with classmates, extending learning socially.

III. COMPETITIVE ANALYSIS

Competitor 1: No Man’s Sky

No Man’s Sky is a large-scale space exploration game that allows players to traverse procedurally generated planets, scan flora and fauna, extract resources, and analyse environmental data. The game strongly emphasises freedom, exploration, and discovery.

Strengths:

- Strong sense of planetary scale and environmental diversity
- Encourages curiosity-driven exploration
- Incorporates scanning and analysis mechanics similar to real scientific exploration
- Visually engaging and immersive

Limitations:

- Designed primarily for entertainment rather than structured learning
- Lacks guided educational scaffolding or clear learning objectives
- Requires long play sessions to meaningfully engage with systems
- Complexity may overwhelm younger or less experienced players

Design Insights:

No Man’s Sky demonstrates the appeal of open-ended planetary exploration but highlights the challenge of balancing freedom with learning outcomes. This informed the project’s decision to adopt focused exploration within a single planet (Mars) and to embed educational content directly into core mechanics, ensuring that learning remains clear, guided, and age-appropriate.

Competitor 2: Star Citizen

Star Citizen is a highly detailed space simulation that prioritises realism in spacecraft operation, planetary environments, and systemic interactions. It aims to replicate the complexity of space travel and exploration at a near-simulation level.

Strengths:

- High level of visual and environmental realism
- Strong sense of immersion and presence
- Detailed planetary and space environments

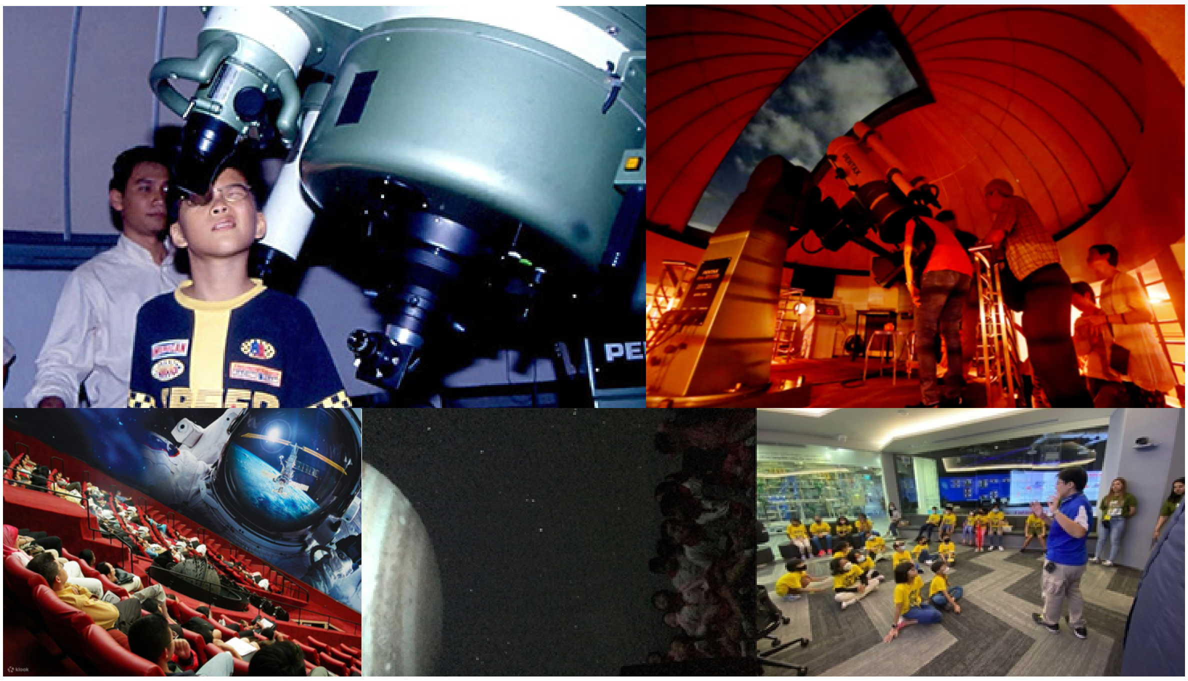
Limitations:

- Extremely complex controls and systems
- Steep learning curve unsuitable for secondary school students
- Requires high-end hardware and long uninterrupted playtime
- Not designed for educational deployment or accessibility

Design Insights:

Star Citizen highlights how realism and complexity can negatively impact accessibility and usability. This reinforced the importance of simplified, intuitive interaction design in the proposed VR experience, particularly for younger users and those with mobility limitations. The project prioritises clarity, comfort, and inclusivity over simulation accuracy.

Competitor 3: Traditional Singapore Science Centre Interactive Exhibits



Singapore Science Centre feature astronomy-related exhibits including telescopes, projection domes, physical models of planets, and interactive digital displays. These exhibits are commonly experienced by secondary school students during learning journeys and aim to introduce scientific concepts through hands-on engagement and visual explanation.

Strengths:

- Designed specifically for educational purposes
- Accessible to a wide range of ages and abilities
- Encourages curiosity through physical interaction and visual aids
- Suitable for supervised group learning environments

Limitations:

- Interactions are typically brief and isolated, limiting depth of engagement
- Learning is often passive or observational rather than exploratory
- Students are unable to experience scientific processes from a first-person perspective
- Limited opportunity for personalised pacing or progression

Design Insights:

While science centre exhibits are effective at sparking interest, they lack immersive continuity and embodiment. This informed the decision to design a VR experience that complements physical exhibits by allowing students to actively explore, investigate, and make decisions within a simulated environment, extending learning beyond observation into experiential participation.

IV. FIGMA PROTOTYPE

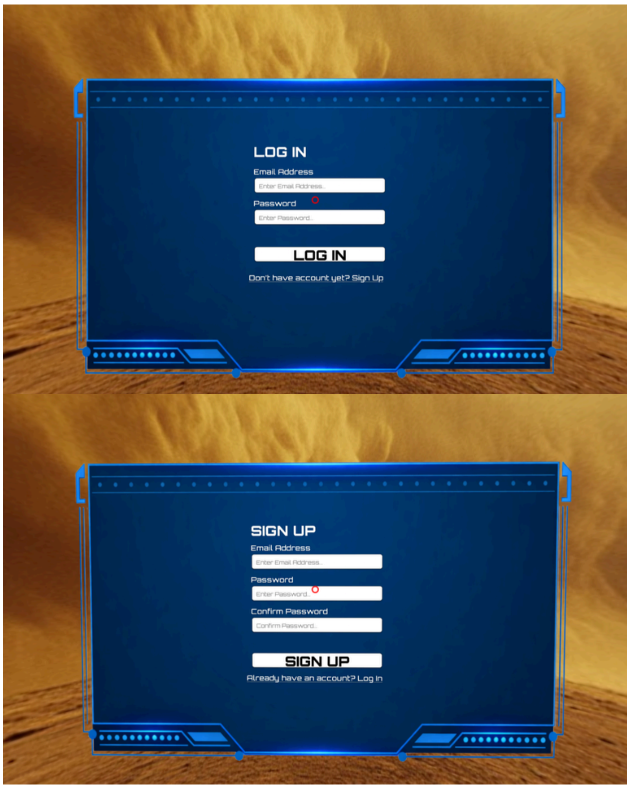
Medium Fidelity Figma Prototype:
https://www.figma.com/design/cbF2KqBdfJ4QH7wH5ozpm7/4-Fingers-Figma-Prototype-XR?node-id=502-2&t=BIFxXBpJDH8ny9yF-1

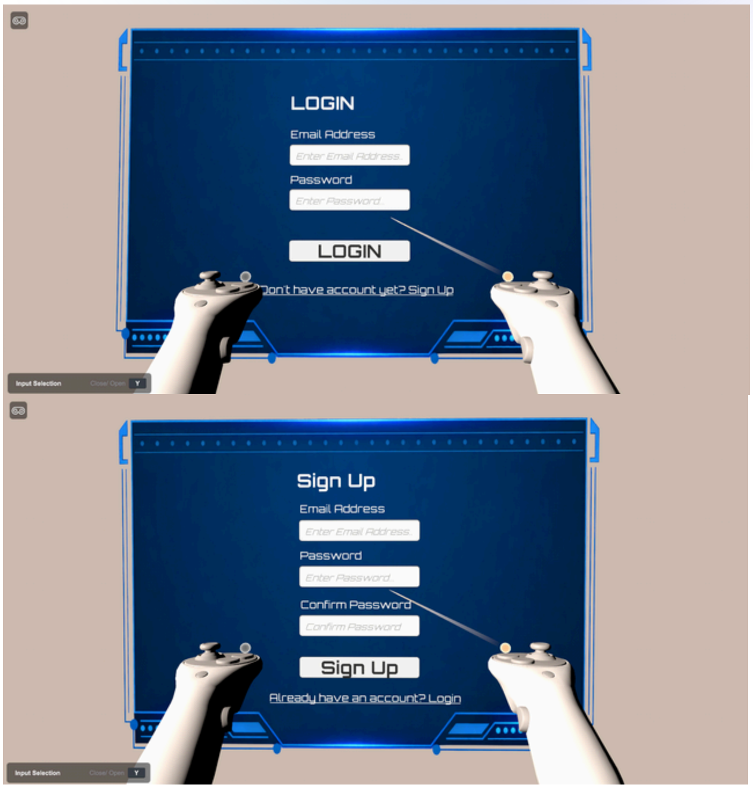
Draft XR Prototype: https://app.draftxr.com/vr/m5Evwf

Figma design VS in-game UI

Tutorial Figma design

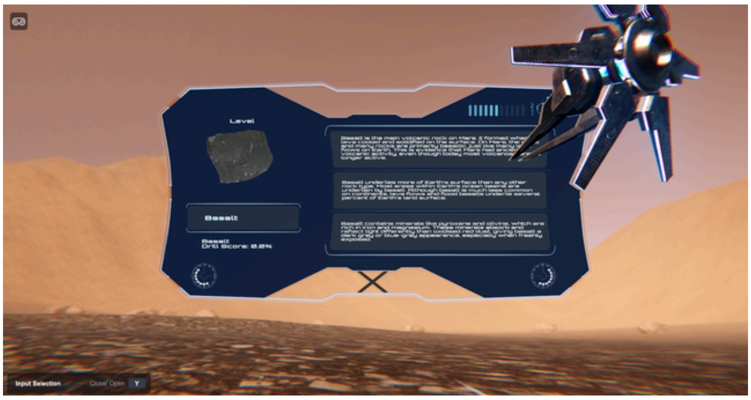
In-game tutorial UI





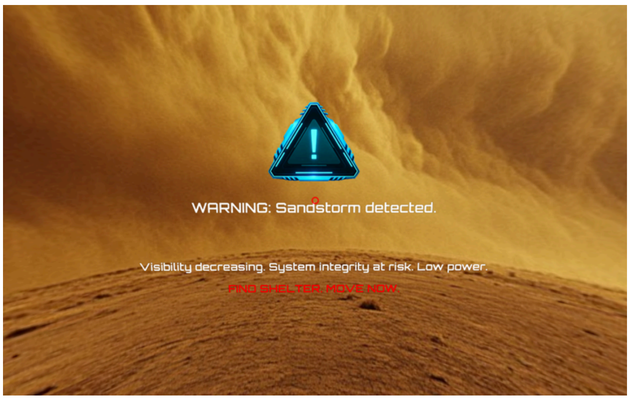
Login / Sign up Figma design

In-game Login / Sign up UI



Info panel Figma design

In-game info panel UI



game start warning Figma design

In-game warning UI

V. VISUALS

a. Screenshots from actual Unity prototype

Login

Sign Up

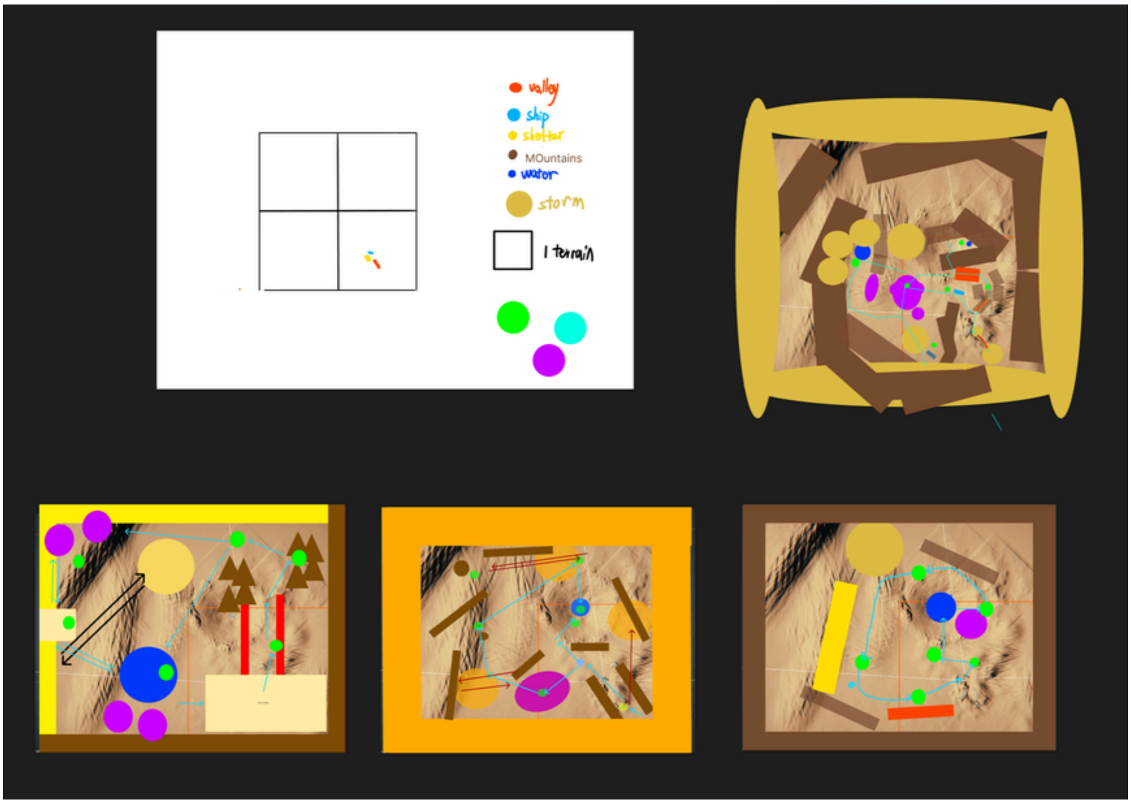
Game start warning

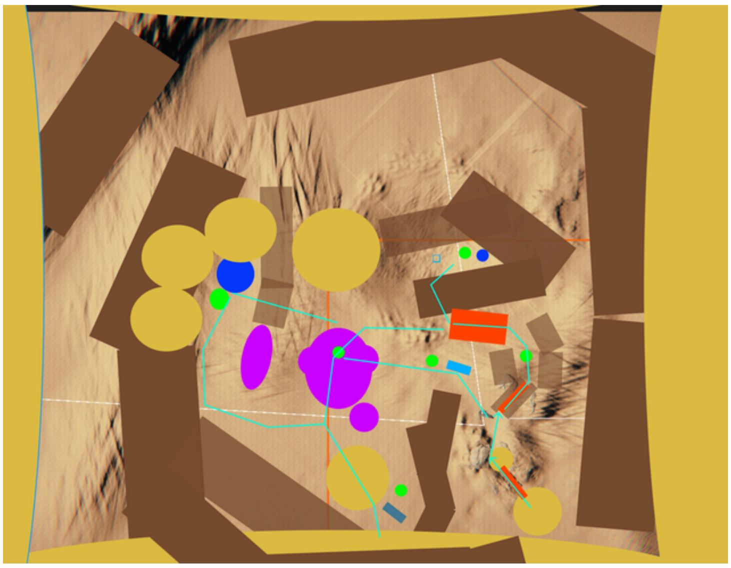
tutorial

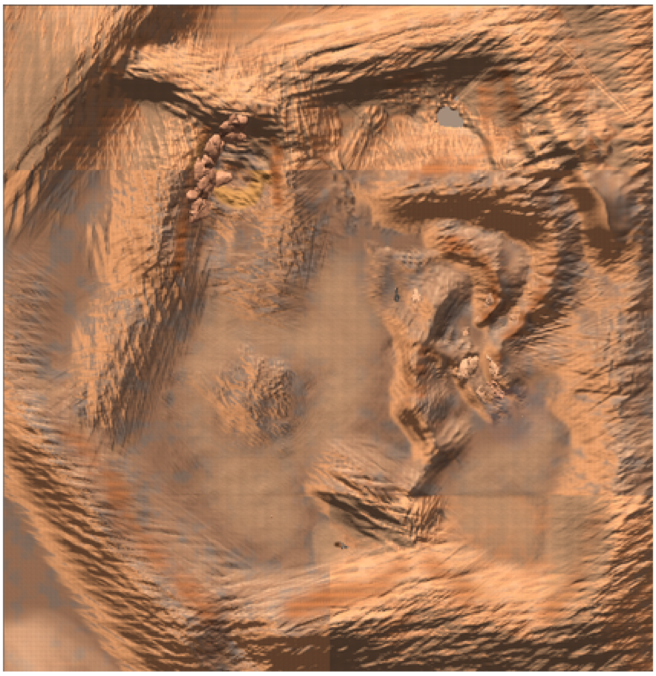
sample infomations

spaceship interior

b. Supporting visuals (ie. Sketches, references)







Terrian Map Planning
& Actual Terrian in Unity

tutorial sketches

badges designed for the website achievements

VI. SUPPORTING RESEARCH

a. Major Points of Consideration for UX When Designing for VR (Meta Quest Platform)

When designing a VR experience for head-mounted displays such as the Meta Quest series, several key UX considerations must be addressed to ensure comfort, accessibility, and usability, particularly for first-time and younger users.

One major consideration is **motion comfort**. Artificial locomotion in VR can cause motion sickness if not handled carefully. To reduce discomfort, movement should be smooth, predictable, and controlled by the user. Sudden camera movement, forced rotations, or rapid acceleration should be avoided. As a result, the proposed experience uses controller-based locomotion at a controlled speed and avoids fast or involuntary camera motion.

Another important consideration is **interaction simplicity**. VR users, especially students with limited prior experience, benefit from intuitive, natural interactions that do not require memorising complex button combinations. Hand and arm-based actions such as pointing, swiping, grabbing, and rotating objects are more easily understood and reduce cognitive load. This informed the design of interactions such as scanning, wiping, and repairing, which rely on simple, physical gestures.

Visual clarity and readability are also critical in VR. Text-heavy interfaces can be difficult to read in headsets and may cause eye strain. Information should be delivered using visual cues, icons, spatial placement, and short instructional prompts rather than long text descriptions. In the proposed experience, learning content is embedded into gameplay feedback and visual effects instead of relying on traditional UI panels.

Lastly, play space and safety must be considered. Many VR users may be playing in limited physical spaces, particularly in public or educational settings. Designing experiences that function within a compact, stationary play area helps ensure safety and accessibility. The proposed game supports seated play and does not require users to physically walk around, making it suitable for deployment in supervised environments such as science centres.

b. On hardware (Meta Quest 2&3, HoloLens 2, Apple Vision Pro)

Primary Development Hardware: Meta Quest 2

The VR experience is developed and tested using the Meta Quest 2, as it is the headset currently available to the project team. All interaction design, performance optimisation, and usability testing are conducted on this device.

The Meta Quest 2 supports inside-out tracking and handheld controllers, enabling intuitive interaction through pointing, grabbing, and gestural input. These features align well with the project's design focus on hand- and arm-based interactions such as scanning, wiping, and repairing. Its standalone nature also makes it suitable for deployment in supervised environments such as science centres, where external sensors and high-end PCs may not be practical.

However, the headset has hardware limitations, including reduced processing power compared to PC-tethered VR systems. This necessitates optimisation in areas such as polygon count, lighting, shaders, and particle effects to ensure smooth performance and user comfort.

Reference Hardware: Meta Quest Series (Newer Models, e.g. Meta Quest 3)

Newer standalone VR headsets in the Meta Quest series offer improved performance, display resolution, and tracking accuracy. Research into these devices highlights how higher visual clarity and enhanced environmental detail could improve immersion and readability in future iterations of the experience.

Although the current project is not developed on these devices, awareness of newer hardware capabilities informs forward-looking design considerations such as scalable visual quality, flexible interaction systems, and potential enhancement of visual effects without altering core gameplay mechanics.

Reference Hardware: HoloLens 2

The Microsoft HoloLens 2 is a mixed reality headset that overlays digital content onto the physical environment. Unlike VR headsets, it allows users to remain aware of their surroundings while interacting with virtual elements.

Research into HoloLens 2 highlights important UX considerations such as limited field of view, spatial anchoring of digital content, and hands-only interaction without traditional controllers. While the current project is designed for full immersion in VR, these insights reinforce the importance of clear visual hierarchy, minimal UI clutter, and intuitive gesture-based interaction.

Reference Hardware: Apple Vision Pro

The Apple Vision Pro represents a newer direction in spatial computing, emphasising high-resolution displays, eye tracking, and natural hand gestures as primary input methods.

Studying Apple Vision Pro informs future-facing interaction design considerations, particularly the reduction of controller dependency and the integration of interface elements directly into the user's spatial environment. Although the current project does not support eye-tracking or gesture-only input, these trends support the project's emphasis on natural, embodied interaction and minimal reliance on traditional menus.

Summary

By developing on Meta Quest 2 while researching other contemporary XR devices, the project demonstrates an understanding of both practical development conditions and broader hardware trends in immersive technology. This approach ensures that design decisions are grounded in real testing while remaining informed by current and emerging XR platforms.

VII. CONSIDERATIONS TO INCLUSIVE DESIGN

Possibility of Catering to People with Limitations

Yes, the application is designed to cater to users with **mobility-related limitations**, particularly individuals who use wheelchairs or have difficulty with lower-body movement. The experience does not require physical walking, standing, or large-scale body movement. Instead, in-game locomotion is controlled via handheld controllers, while interactions are primarily performed using **hand and arm gestures** such as scanning, swiping, selecting, and placing objects.

By minimising reliance on physical leg movement and large play areas, the experience allows users to remain seated throughout gameplay. This makes the VR experience more accessible to students with mobility impairments, as well as users who may experience fatigue or discomfort during prolonged standing.

Additional inclusive considerations include:

- A compact play area suitable for seated use
- Clear visual cues and guided objectives to reduce cognitive overload
- Simple and intuitive interactions designed for first-time VR users

a. Groups of People Who May Be Excluded by the Design

Despite inclusive considerations, certain groups may still be excluded or face challenges when using the application:

- **Users with limited upper-limb mobility:**
  As core interactions rely on hand and arm movements, users with restricted arm or hand function may find it difficult to perform scanning, wiping, or object placement actions.
- **Users with strong handedness preferences or one-handed use:**
  Some interactions may assume two-handed controller usage, which could disadvantage users who rely heavily on a single dominant hand or can only operate one controller comfortably.
- **Users with severe visual impairments:**
  The experience relies heavily on visual feedback, environmental cues, and spatial awareness. Users with significant visual impairments may not be able to fully engage with the gameplay without additional assistive features.

These limitations are acknowledged as part of the current project scope and may be addressed in future iterations.

b. Inclusive Design Practices Applied

Categories of Practises for Inclusive Design
1. Tell diverse stories
2. Avoid stereotypes
3. Adopt accessibility
4. Localise for culture
5. Use colour mindfully
6. Encourage self-expression

With reference to the Categories of Practices for Inclusive Design, the project incorporates the following considerations:

1. Adopt Accessibility

The game is designed to function without physical leg movement, allowing users to remain seated throughout the experience. Locomotion is controller-based, and interactions focus on upper-body actions. This directly supports users with mobility limitations, including wheelchair users, and aligns with accessibility-focused XR design principles.

2. Avoid Stereotypes

The player character is a **robotic rover**, avoiding human-specific assumptions related to physical ability, gender, or identity. This abstraction prevents stereotyping and ensures that no single user group is implicitly excluded through character representation.

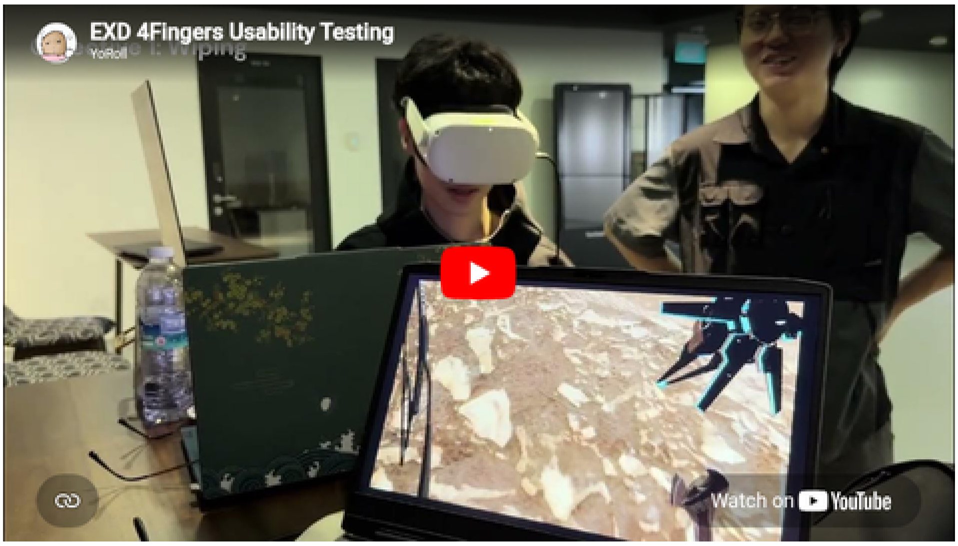
3. Use Colour Mindfully

Important gameplay elements such as scan results, interactable objects, and task indicators are supported by **icons, shapes, and positional cues**, rather than relying solely on colour. This reduces dependence on colour differentiation and supports users with colour vision deficiencies.

4. Localise for Culture

The experience is designed for deployment in Singapore-based educational environments such as science centres and school learning journeys. Language use, instructional tone, and educational framing are kept neutral and aligned with local learning contexts, ensuring cultural relevance and clarity for Singaporean students.

VIII. USABILITY TESTING



Watch the video: https://youtu.be/TrPR8ih0F5s

Date: 10/02/2025
Team: 4 Fingers
Participant: Rayne

2 Core Objectives:
1. Wiping - use the wiper to clean the screen
2. Repairing - since the player get damaged by the sandstorm, find a shelter and repair the player itself.

Feedback:
1. The socket of the wiper could be improved, since it's difficult to put the socket back to where it should be. And if the player just left the wiper on the ground, it's very easy to lose it.
2. More instructions during the game. UI needs to improve also. Can be more sign posting.
3. Everything else (e.g., the environment) is pretty cool.

All the problems & feedbacks mentioned above WE HAVE SOLVED IN OUR FINAL VERSION OF THE GAME!

SECTION 4 - ANNEX

PROJECT TEAM – 4FINGERS

The project is developed by Team 4 Fingers, a multidisciplinary group combining expertise in game development, UI/UX design, 3D modelling, and backend systems.

Name	Role	Responsibilities	Tools / Software
Richard	Team Leader, Game Developer	Core gameplay systems, XR interaction, Meta Quest deployment	Unity, Meta Quest
Rui Min	Backend Developer	Website integration, Firebase systems, backend logic	Firebase, Unity
Baihui	UI/UX Designer	Game UI design, interaction flow, game & UX documentations	Figma, Unity, Canva
Yifan	3D Artist	3D modelling and asset creation for objects, effects and environments	Maya, Blender, Unity

Idea Brainstorm: https://www.figma.com/design/IO2qbWo6fgXNFB7xw7OmYZ/IP-Ideas?node-id=0-1&t=qrNgRhpuZ8qEfR9V-1

AI Assistance (ChatGPT) Disclosure
Portions of the User Journey Map and Core Gameplay Loop diagram were generated with assistance from ChatGPT (OpenAI) based on our project brief and design decisions. The team reviewed and edited the outputs for accuracy and alignment with our final game design. (Accessed: [11 Feb 2026]).