Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

METAVERSE, XR, AND GAME APPLICATION

MMPDG501

Design Game Applications, Metaverse, and XR

RQF Level: 5

Learning Hours 100

Credits: 10

Sector: ICT and Multimedia

Trade: Multimedia Production

Module Type: Specific Module

Curriculum: MMPDG5001 TVET Certificate V in Multimedia production

2024-25

Issue Date: April 2024

<table>
<tr><td>Purpose statement</td><td colspan="6">This module aims to equip learners with knowledge and skills necessary to develop Game, Metaverse and XR applications. By the end of this module, learners will be able to design multimedia solutions using XR, Game applications and Metaverse. Each learner will be able to perform these tasks independently following the local and international market standards.</td></tr>
<tr><td>Learning assumed to be in place</td><td colspan="6">3D Modelling, 2D Animation, UI Design</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>38%</td><td rowspan="4">Formative assessment</td><td>40%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">62%</td><td rowspan="3">60%</td></tr>
<tr><td>Group project and presentation</td><td>20%</td></tr>
<tr><td>Individual project /Work</td><td>42%</td></tr>
<tr><td colspan="3"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competence and Performance Criteria

Elements of competence	Performance criteria
1. Create game concept	**1.1.** Target audience is appropriately identified in accordance with game genre
	1.2. Player role is properly determined in line with player input
	1.3. Characters are properly defined according to character styles and purpose
	1.4. Game rules are properly set in according with Player Interaction
2. Design game levels	**2.1.** Character's challenges are effectively developed based on Game story and settings
	2.2. Actions are properly created based on game mechanics and physics
	2.3. Game world is properly designed according to its type and components.
	2.4. Core mechanics of game are designed according to Technical Feasibility
3. Setup game engine	**3.1.** Game engine is properly selected according to their features
	3.2. Application Programming Interface (APIs) is properly selected according to its supported game engine
	3.3. Basic game code is properly run according to the functionality of game components
4. Build a game	**4.1.** Game environment is properly set according to the functionality of game engine
	4.2. Animations are properly added to game engine in accordance with animation types.
	4.3. Game prototype is properly produced according to their types

5. Develop UI/UX for physical environment	**5.1.** Physical user interface is properly designed in accordance with physical requirement
	5.2. Menus are properly created in accordance with console requirement
	5.3. Navigation and other interactive elements are effectively designed according to the design environment.
	5.4. Assets are properly customized according to the environment scenarios.
6. Perform Hardware integration	**6.1.**Drivers are properly installed and configured based on the system requirements
	6.2. Sensors and other peripherals are properly calibrated in accordance with the designed environment.
	6.3. 3D models and other avatars are seamlessly immersed in the environment according to interactivity techniques.
	6.4. Complete platform integration and optimization are effectively ensured in accordance to specific hardware features and capabilities.
7. Perform Metaverse Deployment	**7.1.** Hosting environment is properly prepared in accordance to metaverse deployment requirements
	7.2. Network infrastructure and security measures are effectively set in place according to system requirements.
	7.3. Metaverse is properly released according to the designated platform.
	7.4. Deployment process is correctly documented according to work done.
	7.5. Metaverse is successfully tested according to localization and internationalization testing methods.

Intended Knowledge, Skills and Attitude

Knowledge	Skills	Attitude
✓ Describe types of Games ✓ Identify types characters ✓ Identify variety of character actions ✓ Identify types of game engines ✓ Describe game environments ✓ Analyse application programming interface ✓ Explain basic game codes ✓ Identify types of character rigging ✓ Identify export formats Assess XR technologies Evaluate Game's environment	✓ Create reusable and modular components for efficient code maintenance. ✓ Build responsive and dynamic user interfaces using React native. ✓ Implementing navigation and routing within a react native mobile application to ensure smooth transitions and intuitive user navigation. ✓ Integrate third-party libraries and APIs into a React native application. ✓ Debug and troubleshoot skills in a react native development environment ✓ Develop a Game story for the intended experience ✓ Design game characters for interactions ✓ Set game environment ✓ Create game assets ✓ Rig characters and Models ✓ Create key frames for animation ✓ Develop prototypes for testing ✓ Organize tasks and Resources ✓ Project management skills ✓ Visualization concept for modelling ✓ Design test plans for drivers and systems ✓ Use embedded system testing tools and techniques ✓ Analyze test results for improvement	✓ Being adaptable to iterate based on feedback. ✓ Perseverance to see projects through to completion. ✓ A genuine Enthusiasm for video games ✓ Desire to create something fun and engaging ✓ Ability to communicate vision and ideas to other team members. ✓ Effective collaboration for bringing a game designer's vision to life. ✓ Being receptive to feedback from play testers for better refining the game design. ✓ A solid grasp of game mechanics, and engaging experience. ✓ Adaptable to learn new tools and software. ✓ Prioritize gamers experience

Indicative contents	
Learning outcomes	**At the end of the module the learner will be able to:** 1. Create game concept 2. Design game levels 3. Setup game engine 4. Build a game 5. Develop UI/UX for physical environment 6. Perform Hardware integration 7. Perform Metaverse Deployment
Learning outcome 1: Create game concept	**Learning hours: 10 hours**
Indicative content	

- **Identification of target audience**

✓ Target audience

- Children and Teens
- Young Adults
- Adults and Seniors
- Gender

✓ Game genres

- Educational Games
- Sports Games
- Simulation Games
- Adventure Games
- Action Games

- **Determining of player role**

✓ Player input

- Buttons & Controllers
- Touchscreens
- Mouse & Keyboard

- Voice Command
- Motion Controls
- VR and AR Input
- Haptic Feedback
- Gesture Input

✓ Player role

- Explorer
- Problem Solver
- Strategist
- Creator

- **Defining character**

✓ Character Styles

- Realistic
- Cartoonish
- Stylized

✓ Character Purposes

- Protagonist (Player Character)
- Antagonist
- Supporting Characters

- **Setting of game rules**

✓ Game rules

- Structure and Fairness
- Objectives and Outcomes
- Challenge and Fun Balance
- Player choice and strategy

✓ Player interaction

- Player Input Mechanisms
- Action Resolution
- Movement Controls

➢ Object, character and camera Interaction ➢ Goal Achievement ➢ Reward systems	
Resources required for the learning outcome	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
Materials	Sensors, Batteries or Rechargeable Batteries for Controllers, Disposable Hygiene Covers for Headsets, Replacement Cables or Adapters, Screen Protectors for Mobile Devices, Game Discs or Digital, Game Codes, Game Pads, Game-specific Peripherals (e.g., steering wheels, flight sticks), Manuals and Guides
Tools	Projectors, Flipchart, XR Development Kits (SDKs, HDKs), XR Content Creation Tools (3D modeling software, animation tools), XR Simulation Software, Gaming Consoles (PlayStation, Xbox, Nintendo Switch, mice, keyboards,), Tracking System, Calibration Tools, Debugging and Profiling Tools Game Engines (Unity, Unreal Engine, etc…), Version Control Systems (Git, SVN) and collaboration platform (Slack,Bug Tracking Systems), Performance Testing ToolsGame Analytics Tools
Facilitation techniques	• Group discussion on XR, Game and Metaverse technologies • Demonstration on project plan • Practical exercise on designing a project goals
Formative assessment methods /(CAT)	• Oral assessment • Written assessment • Practical assessment

Learning outcome 2: Design game levels	Learning hours: 15 hours

Indicative content

- **Development of character challenges**
  - ✓ Overcoming Obstacles
  - ✓ Resource Management
  - ✓ Time pressure
  - ✓ Social challenges
- **Creating Actions**
  - ✓ Movement
  - ✓ Interaction
  - ✓ Inventory Management
- **Designing Game world**
  - ✓ Linear worlds
  - ✓ Open Worlds
  - ✓ Dynamic and Unpredictable
  - ✓ Self-contained experience
- **Deigning game core mechanics**
  - ✓ Two analog sticks
  - ✓ Face buttons
  - ✓ Triggers
  - ✓ Motion Tracking
  - ✓ Touch and swipe

Resources required for the learning outcome	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.

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Facilitation techniques	• Group discussion on virtual environment design • Demonstration on 3D design • Practical exercise on Modelling
Formative assessment methods /(CAT)	• Oral assessment • Written assessment • Practical assessment

Learning outcome 3: Setup game engine	Learning hours: 15 hours

Indicative content

- **Selecting game engine**
  - ✓ Graphics Rendering
    - 2D sprites
    - 3D models
    - Lighting
    - Shadows
    - Special effects
  - ✓ Physics Simulation
    - Collision detection,
    - Rigid body dynamics,
    - Constraints
    - Gravity and friction.
  - ✓ Audio System
  - ✓ Scripting Support
    - C#
    - JavaScript
    - Python
  - ✓ Asset Management
  - ✓ Cross-Platform Support
  - ✓ Editor Tools
    - Integrated development environments (ides)
    - Visual editors
    - Testing games
    - Scene editors
    - Level editors

- Animation editors
- Debugging tools

- **Selection of Application Programming Interface (APIs)**

✓ Graphics APIs

- DirectX 11/12
- OpenGL
- Vulkan
- Metal (for iOS)
- HTML5 Canvas (browser-based games)
- OpenGL ES 3.0

✓ Input APIs

- Unity Input System
- XInput (Windows)
- HID (macOS)
- Unreal Input System
- Godot Input System
- CryInput
- Browser-based input

✓ Scripting game actions

- Scripting player movement
- Scripting player combat
- Scripting player interaction

✓ Running of basic game codes

- Loops
- Conditional Statements
- Variables
- Function

Resources required for the Learning outcome	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
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Facilitation techniques	• Group discussion on UI and UX physical development • Demonstration on prototyping of physical devices • Practical exercise on interactive elements implementation
Formative assessment methods /(CAT)	• Oral assessment • Written assessment • Practical assessment

Resources required for the Learning outcome	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
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Learning outcome 4: Build Game	**Learning hours: 20 hours**
Indicative content	

- **Set Up game environment**
  - ✓ Terrain
  - ✓ Buildings
  - ✓ Foliage
  - ✓ Weather Systems
- **Adding animations**
  - ✓ Idle animation
  - ✓ Locomotion animation
  - ✓ Action Animation
- **Producing game Prototypes**
  - ✓ Low-fidelity porotypes
  - ✓ Mid-fidelity Prototypes
  - ✓ High-Fidelity Prototypes

Learning outcome 5: Develop UI/UX for physical environment	Learning hours: 10 hours

Indicative content

- **Designing physical interface**
  - ✓ Base Controller
    - Joysticks
    - Directional Pad
    - Action Buttons
    - Pressure-sensitive triggers
  - ✓ Metaverse Interaction tools
    - Spatial Mapping Camera
    - 3D Object Manipulation
    - Haptic Feedback Gloves

- **Creating Menus**

✓ Display the menu options

- Define a function to display the menu options to the user.
- Home/Hub
- Explore
- Social
- Inventory
- Settings

✓ User input

✓ Process the user's choice

✓ Repeat until exit

- Wrap the menu display, user input, and option processing steps in a loop to create an interactive menu

- **Designing navigation and other interactive elements**

✓ Design navigation options

- Walking
- Running
- Flying
- Teleportation
- Vehicle-based movement

✓ Implement navigation controls such as:

- Keyboard inputs
- Mouse interaction
- Gesture based controls

✓ Design and implement interactive objects within the virtual environment.

- Manipulate and activate the user actions

✓ Incorporate interaction between users.

- **Customizing assets**

✓ Virtual assets

- Cosmetics
- Equipment
- Consumables

✓ Metaverse

✚ Avatars ✚ Digital Fashion ✚ Digital Collectives

Resources required for the indicative content	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
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Facilitation techniques	• Group discussion on UI and UX physical development • Demonstration on prototyping of physical devices • Practical exercise on interactive elements implementation
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Learning outcome 6: Perform Hardware integration	Learning hours: 5 hours

Indicative content

- **Assessing device compatibility**

✓ Define target devices to support the application

- Determine the specific devices (VR, AR, XR, MR, Smartphones, tablets, Dedicated VR headsets etc…)
- Analyse the capabilities and limitations of each device
- Outline hardware requirements (CPU, GPU, RAM, storage, graphics cards, audio devices, input devices (controllers, sensors, etc.)

✓ Configure drivers

- Check for driver compatibility
- Compatibility on Operating System (OS)
- Compatibility on XR or Game platform
- Obtain and Install drivers
- Verify driver installation
- Update drivers

- **Calibrate Sensors and other peripherals**

✓ Determine the specific sensors and peripherals used in your application.

- Motion controllers
- Haptic feedback devices
- Eye-tracking cameras
- Other specialized input devices

✓ Familiarize with the calibration requirements and parameters for each sensor or peripheral

- Position
- Orientation
- Sensitivity
- Specific calibration patterns

- ✓ Set up an appropriate environment for calibration
  - Clearing the space of obstacles
  - Ensuring proper lighting conditions
  - Setting up specific reference points
- ✓ Perform initial device setup
  - Connect the sensors and peripherals to the appropriate hardware
  - Install any necessary drivers or software packages
- ✓ Sensor calibration
- ✓ Peripheral calibration
- ✓ Verify the calibration accuracy

- **Immersion of 3D**

- ✓ Building virtual world
  - Visual fidelity
  - Sense of Scale
  - Variety and Details
- ✓ Enhancing Player Interactions
  - Physical Interactions
  - Realistic movements
- ✓ Avatars and Player Identity
  - Customization Options
  - Emotional Expression

- **Ensure Complete platform integration and optimization**

- ✓ Optimize assets and graphics
- ✓ Conduct Performance profiling and optimization
  - Use profiling tools to measure factors such as CPU, GPU, and memory usage.
  - Identify bottlenecks and areas for improvement
  - Optimize code, shaders, and rendering techniques
- ✓ Input and control optimization

- ✓ Test on target devices
- ✓ Ensure adaptation to the platform's capabilities
- ✓ Ensure user experience and usability

Resources required for the indicative content	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
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Facilitation techniques	• Group discussion on UI and UX physical development • Demonstration on prototyping of physical devices • Practical exercise on interactive elements implementation
Formative assessment methods /(CAT)	• Oral assessment • Written assessment • Practical assessment

Learning outcome 7: Perform Metaverse Deployment	Learning hours: 5 hours

Indicative content

- **Preparing the hosting environment**

✓ XR hosting environment preparation

✓ Game Application hosting environment preparation

✓ Mateverse hosting environment preparation

- **Setting up the network infrastructure and security measures**

✓ Configure network infrastructure

- Select network infrastructure based on capacity requirement
- Perform proper configuration

✓ Configuring security measures

- User Authentication and Access Controls
- Encryption and Secure Communication
- Secure management of virtual assets or currencies
- Conduct vulnerability assessments and penetration testing
- Plan Security Monitoring and Incident Response.

- **Releasing application to the designated platform**

✓ Publishing XR application to the hosting environment

✓ Publishing the Game Application to the hosting environment

✓ Publishing Mateverse system to the hosting environment

- **Documenting the deployment process**

✓ Development of user manuals

✓ Development of release notes,

✓ Privacy Policy

✓ Terms and conditions

✓ Developing the marketing materials

- **Testing metaverse**

✓ Localization and internationalization testing methods

- Language localization
- Date and Time Formats
- Currency Conversion
- Cultural Sensitivity
- Accessibility Testing for people with disabilities
- Regional Content Filtering
- Geo-blocking and Regional Restrictions

✓ Various testings

- Functional testing
- Compatibility Testing
- Performance Testing

✓ Quality assurance and user experience collection

Resources required for the Learning outcome	
Equipment	Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.), Tracking devices, Development Kits, PCs and Mobile Devices, Game Testing Equipment, Graphic cards.
Materials	Sensors, Batteries or Rechargeable Batteries for Controllers, Disposable Hygiene Covers for Headsets, Replacement Cables or Adapters, Screen Protectors for Mobile Devices, Game Discs or Digital, Game Codes, Game Pads, Game-specific Peripherals (e.g., steering wheels, flight sticks), Manuals and Guides
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Facilitation techniques	• Group discussion on UI and UX physical development • Demonstration on prototyping of physical devices • Practical exercise on interactive elements implementation
Formative assessment methods /(CAT)	• Oral assessment • Written assessment • Practical assessment

Integrated/Summative assessment (For specific module)

Integrated situation

Disclaimer: The following scenario is used for academic purposes. Information and activities indicated do not describe the situation that has happened.

Scenario: The research conducted by MINEDUC in 2023 revealed that students in history domains lacked the exposure and access to ancient artifacts that hod crucial point in history of their country and cannot afford to travel internationally to access their museums. As consequence Teaching of those subjects became predominantly theoretical than practical and it contributed to lower performance of graduates on the labour market.

In order to solve this challenge MINEDUC wanted to implement a virtual environment-based learning program for students and teachers to learn about the metaverse hence contributing to the development of relevant solutions.

The O'Genius Ltd is a software development company that has received a challenge of coming up with the platform and story development that aligns with the entrepreneurship module taught in TVET schools (General Education program). The management has decided to respond to the challenge by developing a metaverse simulating the ahistorical virtual Museum national with section that are international. The management has allocated two months' time for this activity. You are an employee of O'Genius Ltd leading this project and your task is to develop the required solution as an expert in metaverse.

Resources

Tools	Projectors, XR Content Creation Tools, XR Simulation Software Gaming Consoles, Calibration Tools, Debugging and Profiling Tools, Game Engines, Version Control Systems, Bug Tracking Systems, Performance Testing Tools, Game Analytics Tools
Equipment	Computer, Gaming computers, Headset Devices (VR, AR, MR), Controllers (Hand controllers, motion controllers, etc.) Development Kits, Mobile Devices, , Game Testing Equipment
Materials/ Consumables	Sensors, Game Discs or Digital Game Codes, Game Pads, Game-specific Peripherals

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
Learning outcome 1: Elaborate project plan (10%)	1.1. Target audience are identified	Target audience are identified			**1**
		Game genres are identified			**1**
	1.2. Player role are determined	Player input are determined			**2**
		Player role are determined			**1**
	1.3. Characters are defined	Character styles are defined			**1**
		Character purposes are defined			**1**
	1.4. Game rules are set	Game rules are set			**1**
		Player interaction is set			**2**
Learning outcome 2: Design Game levels (10%)	2.1. Character challenges are developed	Movement are created			**1**
		Interaction is created			**1**
		Inventory management is created			**1**
	2.3. Game worlds are designed	Linear worlds are designed			**1**
		Open worlds are designed			**1**
		Dynamic and unpredictable worlds are designed			**1**
		Two analog sticks are designed			**1**

	2.4. Game core mechanics are designed	Face buttons are designed			**1**
		Triggers are designed			**1**
		Touch and swipe are designed			**1**
Learning outcome 3: Setup game engine (20%)	3.1. Game engine are selected	Graphics rendering are selected			**2**
		Physics simulation is applied			**2**
		Audio system is selected			**2**
		Scripting support is selected			**2**
		Cross platforms are selected			**2**
		Editor tools are selected			**2**
	3.2. Application programming Interfaces are selected	Graphics APIs are selected			**2**
		Input APIs selected			**2**
		Scripting game actions are selected			**2**
		Basic codes are run			**2**
Learning outcome 4: Build game (20%)	4.1. Game environments are set	Terrain is set			**2**
		Buildings are set			**2**
		Foliage are set			**2**
		Weather systems are set			**2**
	4.2. Animations are set	Idle animation is set			**2**
		Locomotion animation is set			**2**
		Action animation is set			**2**
	4.3. Game prototypes are produced	Low-fidelity prototypes are produced			**2**
		Mid-fidelity prototypes are produced			**2**
		High-fidelity prototypes are produced			**2**
Learning outcome 5: Develop UI/UX	5.1. Physical Interface is designed	Base controller is designed			**2**
		Metaverse tools are interacted			**2**

(20%)	5.2. Menus are created	Menu options are displayed			**3**
		User input is created			**2**
		User's choice is processed			**1**
		Repeat until exit is done			**1**
	5.3. Interactive elements are designed	Navigation options are designed			**2**
		Navigation controls are implemented			**1**
		Interaction are integrated			**1**
	5.4. Assets are customized	Virtual assets are customized			**3**
		Metaverse is customized			**2**
Learning outcome 6: Perform hardware integration (10%)	6.1. Device compatibility are assessed	Drivers are configured			**1**
	6.2. Sensors and peripherals are calibrated	Sensors are calibrated			**1**
		Peripherals are calibrated			**1**
		Environment calibration is set			**1**
		Devices are set			**1**
		Calibration is verified			**1**
	6.3. 3D is immersed	Virtual world is built			**1**
	6.3. Platform is integrated and optimized	Assets and graphics are optimized			**1**
		Input and control are optimized			**1**
		User experience and usability is ensured			**1**
Learning outcome7: Perform metaverse deployment (10%)	7.1. Hosting environment is prepared	XR hosting is prepared			**1**
		Game application hosting is prepared			**1**
		Metaverse hosting is prepared			**1**
	7.2. Network infrastructure and security measures are set	Network infrastructure and security measures are configured			**1**
	7.3. Application is released	XR application is published			**1**

		Metaverse system is published			**1**
	7.4. Deployment process is documented	User manuals and release are developed			**1**
		Privacy policy, terms and conditions are developed			**1**
	7.5. Metaverse is tested	Testing methods are localized			**1**
		Testing is done			**1**
Total marks		**100**			
Percentage Weightage		**100%**			
Minimum Passing line % (Aggregate): 70%					

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