

Table 1: Content of the VR Metaverse-based Health Education Program

Week	Session	Goal	Content	Group Tasks	Researcher Tasks
Week 1	Introduction to the Program and Case Study	Introduce students to the VR in metaverse-based health education program, PBL process, action research steps, and the diabetic female case study.	<ul style="list-style-type: none"> <li>- Overview of the program</li> <li>- Introduction to the PBL process steps</li> <li>- Presentation of the case study</li> <li>- Group formation</li> <li>- Problem identification.</li> <li>- Setting learning objectives for each group.</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will listen to the facilitator's explanation and participate in discussion to ensure that they understand the program's objectives, structure, and requirements.</li> <li>- Group members will listen actively, take notes, and ask questions as necessary to ensure that they have a thorough understanding of the case study.</li> <li>- Group members requires to actively participate in forming groups that will work together throughout the program.</li> <li>- They should work collaboratively to identify problems related to the diabetic female case study and propose possible solutions.</li> <li>- They should work together to set learning objectives that align with the identified problem.</li> <li>- Work together to ensure that each group member has a clear understanding of their responsibilities and roles in achieving the learning objectives.</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce the program overview, its aim, and its scope to the students.</li> <li>- Introduce the PBL process, how it relates to the program and how it will enhance their learning experience.</li> <li>- Present the case study.</li> <li>- Guide the students in how to analyze the case study and derive insight from it.</li> <li>- Facilitate group formation and to identify group members' roles (timekeeper, group leader, etc.)</li> <li>- Facilitate problem identification.</li> <li>- Encourage students to think creatively and to come up with unique solutions.</li> <li>- Help the students to set specific, measurable, and achievable objectives.</li> <li>- Guide them in developing action plans.</li> <li>- Facilitate learning process by encouraging active participation.</li> </ul>
Week 2	Exploring Pre-existing Knowledge	Explore pre-existing knowledge, identify	<ul style="list-style-type: none"> <li>- Investigating existing mobile health applications for</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will work together to conduct research on the different mobile health applications available for diabetes management, with each</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce the second session.</li> <li>- Guide the students on how to investigate the existing mobile applications.</li> </ul>

	and Existing Applications	gaps and challenges in existing mobile health applications .	<p>diabetes management</p> <ul style="list-style-type: none"> <li>- Identifying gaps and challenges</li> <li>- Group discussions on pre-existing knowledge</li> <li>- Exploring opportunities for improvement.</li> </ul>	<p>member contributing their findings and insights.</p> <ul style="list-style-type: none"> <li>- Group members will work together to identify the gaps and challenges present in the existing mobile health applications.</li> <li>- Group members will engage in discussion, providing feedback and ideas to one another, to ensure a comprehensive understanding of the challenges and gaps.</li> <li>- Group members will share their pre-existing knowledge and experience with mobile health applications and diabetes management.</li> <li>- Group members will engage in dialogue and debate, with each member sharing their unique perspectives and insights.</li> <li>- Group members will work together to identify opportunities for improvement in existing mobile health applications for diabetes management.</li> <li>- They will brainstorm and propose potential solutions to address the identified gaps and challenges, leveraging their collective knowledge and experience.</li> </ul>	<ul style="list-style-type: none"> <li>- Encourage them to identify the features of these applications, their strengths and weaknesses, and their potential benefits for patients.</li> <li>- Help the students identify gaps and challenges in existing mobilehealth applications.</li> <li>- Encourage them to think critically about the limitations of these applications and the potential barriers to their adoption.</li> <li>- Encourage the students to share their insights and ideas.</li> <li>- Facilitate students' collaboration and engagements.</li> <li>- Guide the students in exploring opportunities for improvement in existing mobile health applications.</li> <li>- Encourage them to think creatively about how these applications could be enhanced to improve the fulfillment of patients' and healthcare providers' requirements.</li> </ul>
Week 3	Generating Hypotheses and	Develop hypotheses and possible	<ul style="list-style-type: none"> <li>- Brainstorming preferred interfaces,</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will work together to generate ideas for preferred interfaces, resources, tools,</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce the third session.</li> <li>- Facilitate a brainstorming session where the students can discuss their</li> </ul>

	Identifying Learning Objectives	mechanisms for the mobile health application, identify learning objectives.	resources, tools, techniques, and content for the mobile health application - Generating hypotheses	techniques, and content for the mobile health application. - Member will share their ideas and provide feedback on others' suggestions to develop a comprehensive list of preferred features. - Members will work collaboratively to generate hypotheses and possible mechanisms for the mobile health application. - They will engage in active discussion, providing feedback and ideas to one another to ensure a thorough understanding of the potential mechanisms that could contribute to the success of the application. - They will also work together to identify learning objectives that align with the hypotheses and mechanisms developed	preferred interfaces, resources, tools, techniques, and content for the mobile health application. - Guide the students in generating hypothesis related to mobile health applications. - Encourage them to think creatively about the potential mechanisms and outcomes of the application. - Help them refine their hypotheses through critical analysis and discussion. - Guide the students in identifying specific learning objectives related to the mobile health application. - Facilitate learning process.
Week 4	Research and Self-Study	Conduct individual research based on the identified problem and learning objectives.	- Independent research on mobile health application development - Sharing findings within groups - Identifying areas for improvement	- Each group member will be responsible for conducting independent research on mobile health application development, leveraging their unique perspectives, experiences, and expertise. - Group members will share their findings within the group, engaging in active discussion and providing feedback to one another.	- Introduce the fourth session. - Guide the students to conduct independent research on mobile health application development. - Provide them with the necessary resources and support to help them explore the relevant literature and gain a deeper understanding. - Encourage students to share their findings with the other group.

			<ul style="list-style-type: none"> <li>- Planning the preliminary version of the mobile health application</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will identify areas for improvement and work together to develop a plan for the preliminary version of the mobile health application.</li> <li>- Group members will need to demonstrate self-motivation and a strong work ethic to ensure the successful completion of individual research.</li> <li>- Group members needs to be open-minded and receptive to feedback from other group members, incorporating feedback to improve their research and the overall plan for the mobile health application.</li> </ul>	<ul style="list-style-type: none"> <li>- Facilitate group discussions and encourage collaboration and knowledge sharing among the students.</li> <li>- Guide the students in identifying areas for improvement based on their research findings.</li> <li>- Guide the students in planning the preliminary version of the mobile health application.</li> <li>- Encourage them to think creatively and develop a clear plan for the application, including its features, functionality, and design.</li> <li>- Facilitate the learning process.</li> </ul>
Week 5	Developing and Refining the Mobile Health Application	Develop a prototype mobile health application and refine it based on feedback and new knowledge.	<ul style="list-style-type: none"> <li>- Developing the initial mobile health application prototype</li> <li>- Group presentations</li> <li>- Feedback sessions</li> <li>- Refining the application based on feedback.</li> <li>- New knowledge</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will work collaboratively to develop the initial mobile health application prototype.</li> <li>- Each member will bring their unique skill set and expertise to the table to ensure that the prototype is comprehensive and effective.</li> <li>- Group members will engage ingroup presentations, providing feedback to one another on the prototype's strengths and weaknesses.</li> <li>- They will also participate in feedback sessions, receiving feedback from instructors and peers</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce the fifth session.</li> <li>- Guide the students in developing the preliminary version of the mobile health application.</li> <li>- Encourage the students to apply their knowledge and insights gained from previous sessions to create a functional and visually appealing application.</li> <li>- Facilitate group presentations to showcase their application to the other students.</li> <li>- Encourage them to explain the features and functionality of the application and answer questions from their peers.</li> </ul>

			<ul style="list-style-type: none"> <li>- Preparing for the final presentation.</li> </ul>	<p>and incorporating it into the prototype's refinement.</p> <ul style="list-style-type: none"> <li>- Group members will need to be receptive to new knowledge and open to incorporating it into the prototype's refinement.</li> <li>- They will also need to be flexible and adaptable, incorporating feedback and making necessary</li> </ul>	<ul style="list-style-type: none"> <li>- facilitate feedback sessions where the students can receive feedback on their application from their peers and the action researcher.</li> <li>- Encourage constructive criticism.</li> <li>- Guide the students in identifying areas for improvement.</li> <li>- Guide the students in refining the application.</li> <li>- Encourage the students to apply the feedback and incorporate new insights to create final version.</li> <li>- Guide the students in preparing their final presentation.</li> </ul>
Week 6	Final Presentation, Assessment, and Reflection	Present the final mobile health application prototype, assess its effectiveness, and reflect on the learning process.	<ul style="list-style-type: none"> <li>- Final group presentations, assessment of the mobile health application's effectiveness</li> <li>- Reflection on the PBL process</li> <li>- Discussing the next steps for further development and refinement of the mobile</li> </ul>	<ul style="list-style-type: none"> <li>- Group members will work together to showcase the final mobile health application prototype.</li> <li>- Each member will play a crucial role in highlighting the prototype's features and demonstrating its effectiveness in addressing the identified problem and learning objectives.</li> <li>- After presenting the prototype, group members will engage in an assessment of its effectiveness, evaluating the extent to which it addresses the identified problem and achieves the identified learning objectives.</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce the last session.</li> <li>- Facilitate the final group presentations where the students can showcase their mobile health application prototype.</li> <li>- Encourage them to provide evidence of how it meets the identified problem and learning objectives, and its potential effectiveness in addressing the issue.</li> <li>- Guide the students in reflecting on the PBL process. (Both virtual and traditional face-to-face group)</li> <li>- Guide the students in reflecting on the VR experience (For Virtual group only)</li> </ul>

			health application.	<ul style="list-style-type: none"> <li>- They will provide feedback and insights to one another, highlighting areas of strength and potential areas for improvement.</li> <li>- They will explore potential areas for improvement, discuss future research needs, and identify strategies for maximizing the application's effectiveness.</li> <li>- They will explore potential areas for improvement, discuss future research needs, and identify strategies for maximizing the application's effectiveness.</li> <li>- <i>(Traditional face-to-face group)</i> Group members will engage in a reflection on the PBL process, discussing their experiences and insights gained throughout the program.</li> <li>- <i>(Virtual reality group)</i> Group members will engage in a reflection on the PBL process, VR experience and Metaverse. Also, discussing their experiences and insights gained throughout the program.</li> <li>- <i>(Both groups)</i> They will reflect on their individual contributions to the group, the challenges they faced, and the strategies they employed to overcome them.</li> </ul>	<ul style="list-style-type: none"> <li>- Encourage them to share their experiences, insights, and challenges throughout the program, and how the PBL process facilitated their learning. (Both virtual and traditional face-to-face group)</li> <li>- Encourage them to share their experiences, insights, and challenges throughout the program, and how the VR facilitated their learning. (For Virtual group only)</li> <li>- Facilitate a discussion for further development and refinement of the mobile health application.</li> <li>- Encourage the students to think critically about the potential improvements and enhancements that could be made, and how they can be achieved.</li> </ul>
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