EDLAB Project: VR ENHANCED PBL

Project title	PROPOSAL FOR ENHANCING PBL QUALITY THROUGH THE USE OF VIRTUAL REALITY ("VR ENHANCED PBL")	
Project leader (PL):	Roberta Di Palma / Dominik Mahr	
E-mail address PL:	r.dipalma@maastrichtuniversity.nl / d.mahr@maastrichtuniversity.nl	
Telephone nr:	+31617471673	
Faculty / Department:	SBE / MSCM & ERD	
Faculty & name of representative in project	☒FASoS	Claartje Rasterhoff, Costas Papadopoulos, Thomas Frissen, Aodhán Kelly *
	☒FHML	Nynke de Jong
	☒FSE	Stefan Jongen
	☒SBE	Roberta Di Palma, Dominik Mahr, Jonas Heller, Tim Hilken, Simon Beausaert *
	☒FPN	*
	☒LAW	*
	☒UB	*
		*Exact faculty representatives for the project to be specified during the first focus group meeting

☒: Faculty/Contact confirmed

Title and description of project proposal	***From what context has this proposal evolved?*** Reality-enhancing technologies such as Virtual Reality (VR) are gaining traction in many fields of research, ranging from human behavior and psychology to service fields such as education (Loureiro et al., 2020). VR promises to be a tool that can improve students' learning and motivational outcomes in higher education (Majchrzak et al., 2022; Halvorson, et al., 2011; Cowan & Ketron, 2019). Therefore, it has become relevant for universities to understand the scope of technology-enhanced education with VR. As outlined in EDview (2018), there is a need to **develop more creative and diverse PBL formats** within Maastricht University (UM). **This is exactly what VR integration within our PBL classrooms may offer**. Today's global education is becoming increasingly more learner-centric, as all learners are different (Kanmani & Babu, 2015). VR has proven effective in improving learning, by catering to different learner's needs. For example, VR offers the opportunity to improve the flexibility, quality and quantity of feedback and practice scenarios students traditionally experience during PBL sessions, by creating more realistic yet creative environments (Al Farsi et al., 2021). VR integration is not exclusively beneficial for students, but also has the potential to benefit

staff. In fact, VR is enabling educators to experiment with new pedagogies, which allow universities to expand their traditional curricula (AACSB, 2018).

This proposal revolves around the constructivist theory of learning, which lies at the heart of PBL, connecting it to VR technology as a tool to improve student learning and feedback. The aim of the proposal is to innovate digital education at UM, by expanding our current understanding of how to integrate VR within our PBL education. More specifically, this project aims to implement among UM faculties two commonly used VR in education practices, namely **1) training presentation skills in VR and 2) using 360-degree videos to enhance the learning experience within PBL education**. Previous experience with this technology at UM, shows that there is plenty of unrealized potential and need for more research. The aim of this project aligns with UM's mission of complementing our classrooms with innovative hardware, such as VR/AR, and creating "specially equipped spaces for digital collaboration" (Maastricht University, 2021, p. 17-18).

What is/are the goal(s) of the project or what issue will it address?

The aim of this project is to use VR for introducing new and enriching existing **PBL formats at UM** by:

- Developing theoretical and empirical related foundations for VR enhanced education and a UM-wide vision of VR enhanced PBL.
- Building on UM's current VR enhanced learning initiatives across faculties, to create an interconnected and self-supporting network of digital laboratories. This project will take two PBL enhancing VR practices, presentation skills training and 360-degree videos, and aim to increase adoption of these practices across different faculties.
- Leveraging the commonalities and differences of VR uses among the different faculties to develop synergies and learnings that can benefit UM, from students to teachers.
- Fostering usability of VR, by sharing insights gathered and best practices learnt across multiple disciplines.
- Establish VR expertise within the faculties.

About Virtual Reality in education

Virtual Reality (VR) is defined as a rich visualization and analytical platform, capable of providing access to authentic contexts and supporting scholarships across diverse disciplines and faculties (Cook et al., 2019). VR has immense potential in its application to educational settings for quite some time now (Mantovani, 2001; Magomadov, 2020). Various studies have shown that VR can help overcome many of the traditional learning challenges by increasing social interaction, student engagement, focus and information retention. Increasing these factors has shown to lead to stronger dedication and attention to the task at hand (Singhal, Bagga, Goyal & Saxena, 2012; Ke, Pachman & Dai, 2020). Additionally, virtual simulations and integrated artificial intelligence, present in many VR software, have the potential to increase visual and practical skills (Drake-Bridges, Strelzoff & Sulbaran, 2011; Peters & Stamp, 2020).

VR integration has many benefits not only for students, but also for staff. A VR enabled flipped classroom, or a classroom which focuses on student-led-experiences with VR, empowers coordinators and tutors to focus their time and effort on the creation of more efficient and effective

learning activities, which allow for higher flexibility (Sumathi & Devakumari, 2021). Past studies have shown that allowing students to control, to a certain degree, their learning activities can lead to better educational outcomes, such as improved motivation, satisfaction, and confidence, which in turn creates a better learning environment for all stakeholders involved (Al-Zahrani, 2015; Akçayır & Akçayır, 2018). Additionally, VR has recently been found to be a useful tool for teaching staff in handling particular situations, such as difficult student behaviour (Chen, 2022) and student self-confidence (Putri & Rahmawati, 2022).

Types of Virtual Reality experiences that support PBL

VR enables interactions that satisfy the five senses - where the visual, the auditory and the tactile senses are particularly enhanced – to provide experiences that are similar to reality. Presence and immersive interaction are terms commonly associated with VR. Presence refers to the phenomenon where users act and feel as if they are "really there" (Grau, 2007). Immersive interaction refers to the feeling of being included in and interacting with the virtual environment (Witmer & Singer, 1998). Immersive interaction can be seen as a step beyond simply being present in a virtual world, as users' tactile sense also comes into play as they physically interact with the environment. Examples of interaction include simply pressing buttons to make selections in the VR environment but could also be more complex such as simulating real-life scenarios in these new worlds. If considered on a spectrum, presence allows users to passively observe a VR environment, while immersive interaction refers to actively experiencing and changing the VR world. Passive VR is commonly experienced using 360-degree videos. On the other hand, active VR is experienced when using VR-enabled simulators and training platforms, for example when using a presentation skills training software.

Overall, examples of educational VR activities at UM can be summarised in the framework below. Using the provided examples of 360-degree videos and training presentation skills, it is possible to observe that VR activities differ in terms of the type of skill they aim to train, professional versus academic, and the type of participation required by the user, active versus passive.

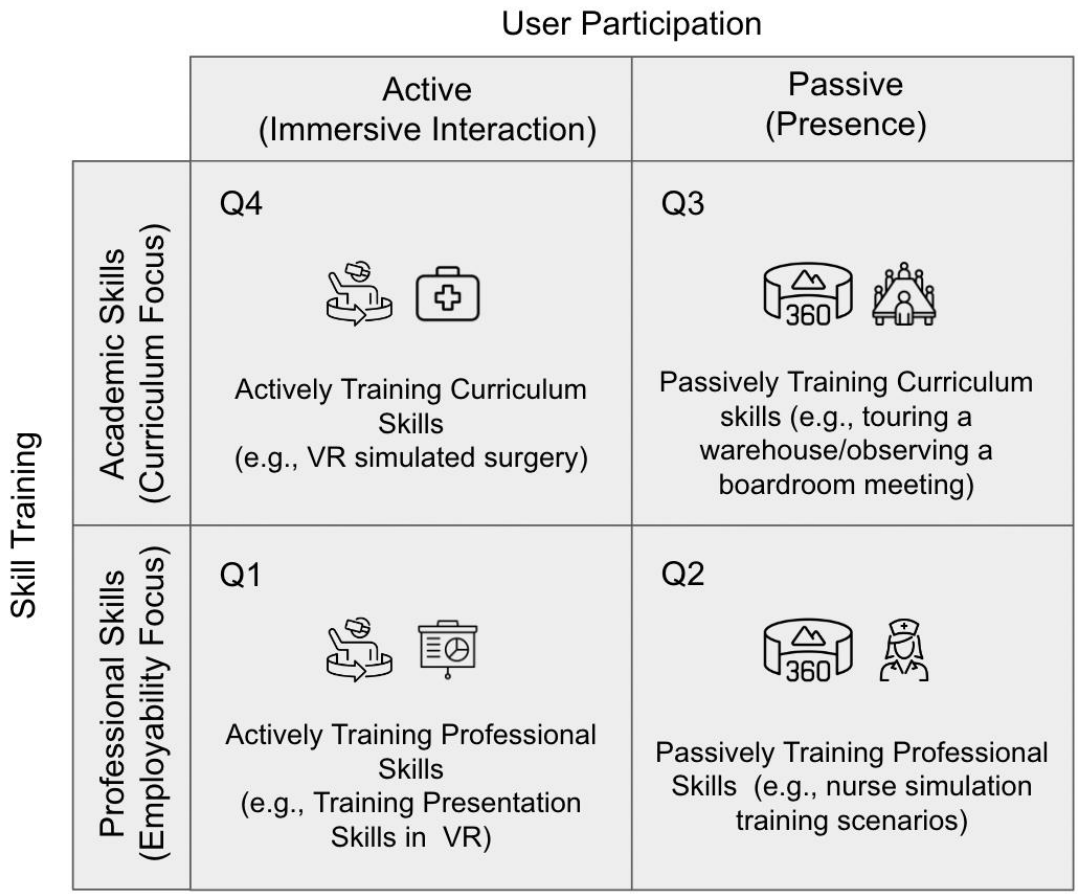

Figure 1: VR enhanced PBL activities across UM

VR applications in constructivist learning settings

At SBE for example, students often are asked to picture themselves in different situations, i.e., in the shoes of a manager, an employee or even the customer of a specific company. VR enables students to visually experience these situations by physically and mentally immersing themselves into a virtual world, which embodies the challenge at hand (Araiza-Alba, Keane, Chen & Kaufman, 2021). Creating more realistic environments and expectations for students through VR, allows them to develop fundamental skills required for business and economics students, such as critical thinking skills. VR, using 360-degree videos, enables students and teachers to simulate real-life scenarios by enabling the feeling of presence which is not as highlighted during traditional PBL sessions. This type of activity only requires passive participation from the user, as no selections and interactions need to be made throughout the experience. The SBE example is easily applicable and adaptable to the needs of other UM faculties. Specific examples of how VR is used across UM faculties can be found in the next section.

A second important implication of VR for PBL, is its ability to help students further enhance their professional, or employability, skills. Unlike traditional university systems, professional skills such as communication and presentation skills, creativity, imagination, discipline, responsibility, and teamwork skills are all known to be at the heart of the PBL learning approach (Hartati, 2022). It is generally more difficult to practice such intangible skills in a traditional classroom, even in a PBL

tutorial. However, using VR we aim to inspire students to think outside of the box and develop a more creative outlook on the problems at hand (Awoke et al., 2021). Additionally, the large availability of VR software on the market, targeted at the practice of these specific soft skills, allows students to receive feedback on their non-content related skills. This is especially useful as tutors often have limited time to provide feedback and thus mainly provide feedback on the content-related aspects of a student's assignment.

Taking the example of presentation skills once more, the quantity of individual feedback for oral presentations, especially in group presentation settings, is often limited and majorly focused on the quality of the presentation's content rather than presenters' form (Wang, Yu & Teo, 2018). However, students seek detailed individual feedback to further enhance their presentation skills (Van Ginkel, 2020). Implementing an automatic, non-content-based feedback system, which provides real-time feedback on the presenter's language, presence, and body language, as well as a supportive audience in VR, greatly benefits students' ability to freely practice and improve their presentation skills. This type of VR environment is immersive and interactive as it requires the user to make selections throughout the entire experience.

Connection to PBL Principles

This project aims to promote the use of educational activities in quadrants 1, 2 and 3, as these are skills which are essential within the learning objectives across study programs at all UM faculties. Additionally, these three teaching techniques through VR, enable the enhancement of most, if not all, of the core educational principles of the PBL learning approach:

- **Contextual**: presence in VR is by default a contextual activity, giving students a more in-depth picture of the outside world and/or simulated difficult-to-experience situations and scenarios within a 'safe' learning environment (e.g., conflict resolution). For example, when training presentation skills in VR, students are provided with a real-life audience, which they would not have when simply practicing in front of a mirror.
- **Constructive**: VR nudges students to activate prior knowledge because they become fully immersed in an experience without access to typical classroom resources (e.g., course literature, internet search) and thus need to apply on what they already have. In turn, this also allows students to develop new knowledge and connections among tasks. For example, when experiencing a 360 video in VR on how to comfort family members after a loss of a loved one, student nurses do not have access to their notes or any distractions from the outside world and, therefore are able to be fully present and learn from the training.
- **Self-directed**: Training skills requires scaffolding techniques, where students are initially provided a lot of support, which is then gradually faded away as they learn in an independent and self-directed way. VR skills training provide such scaffolding, oftentimes in a gamified way, by enabling students to set goals, regulate learnings and reflect on these. For example, using VR for presentation skills might be a mandatory assignment for all students in a course. Later, once they are aware of the availability of this tool, it will be their responsibility to request to practice their presentation skills in VR. This strategy reduces the possibility of becoming dependent on the technology, and rather utilizes VR as a building block used to train these skills.

	• **Collaborative**: Collaboration among students is supported through the enhancement of the previous three elements. Furthermore, VR enables students to meet virtually in a more engaging and inclusive manner than other video conferencing tools used for hybrid education formats (e.g., Zoom). Through this project, the aim is to observe and identify the ways in which VR in PBL leads to more collaboration among students. For example, collaboration could take place through the recording of a group 360 video or dynamic group training in VR, to name a few. ***VR and Assessment in PBL*** It is important to keep in mind that for VR enhanced PBL to be beneficial, there needs to be constructive alignment between the learning goals, assessment methods and the VR activities employed. We believe that the two proposed VR activities are ideally suited as formative assessment methodologies for training both professional and academic skills. As previously mentioned, these types of learning activities are envisioned to lead to reflection on the experience, either directly in VR (e.g., feedback received by the presentation skills software) or directly after the in-class VR experience (e.g., open group discussion on the perceived experience while watching the 360 video). In the future, we also envision VR to become an assessment method tool in itself (e.g., graded VR simulated surgery); however, for now, it is fundamental to first uncover the potentials VR has within our PBL classrooms. ***What is the target group for this project?*** The UM teaching and learning community: programme coordinators, course coordinators, tutors, assessors, mentors, and students. The outcome of this project also is relevant for researchers in the field of educational research.
Preparatory phase and context	**Origin of the project and inter-faculty exploration** ***Which existing initiatives or past projects are related to this project proposal? How can past results be used?*** ***SBE*** At SBE the integration of VR in PBL courses started in April 2021, through the project *SBE Education Innovation*. Since then, VR has been applied in two distinct courses: 1. The first course, **Services Marketing**, is a fundamental part of the third-year specialization in Marketing. More information on this project can be found here: https://www.youtube.com/watch?v=ObP_syT_xpY&ab_channel=SchoolofBusinessandEconomics 2. The second course, **Presentation Skills**, is a second-year elective part of the International Business bachelor. The use of VR was integrated into the course as a practice tool, meaning students were able to practice their final presentation and receive feedback in VR on the latter before their final presentation session.

This project contributed to the creation of the first mixed-reality laboratory of SBE, coined the Digital Experience Lab (DEXLab): https://www.sbe-dexlab.com/

- In the lab, VR is being implemented for research projects, for example by master students for their master theses.
- VR is also implemented in traditional PBL courses using **digital breakout sessions**. A digital breakout session represents a tutorial in which students taking part in a course will spend a tutorial meeting in the lab engaging with VR with a way that adds value to the course. For example, students can try out an experience application inherent to the content of the course.

FHML

At FHML, Nynke de Jong and Silke Metzelthin, both Assistant Professors at the Department of Health Services Research (Health Sciences), have been using VR since 2017.

To prepare **health science students** for their future profession, it is important that they can apply theoretical insights in practice. VR glasses and 360 videos are used to show how district nurses stimulate self-management among their clients. For more information: https://www.youtube.com/watch?v=7rGpLIw7sDI&ab_channel=NynkedeJong

In the **Tutor Training 360** project, run by Nynke de Jong, starting tutors are trained in PBL group dynamics and 'critical incidents' through the use of 360-degree videos. See https://edlab.nl/tutor-training-in-360-degrees/

FSE

At FSE, it is particularly interesting to include VR Trainings for first year Business Engineering students.

- In terms of **professional skills** training, there would be a value in including presentation skills training in VR in the first-year course "Academic Skills"
- In terms of **academic skills** training, content courses such as "Commercialising Science and Technology" and "Materials Engineering" could benefit from the integration of 360 VR videos, to aid with the understanding and memorization of more difficult and abstract concepts.

FASoS

At FASoS, a VR Lab, called *The Plant: Maastricht Studio for Digital Research & Education @FASoS,* is currently being developed. At this faculty, implementation and integration of VR is expected to take place in the following ways:

- FASoS sees potential for VR to be applied for general **academic skills**, such as presentation skills. They are also considering the relationship between PBL and VR in a more systematic way. So, VR as an example of technology enhanced learning with potential for updating PBL as it is now practiced at UM.
- VR could be used for the BA Digital Society there is the course **Maker Cultures**. This is project-based and one of the projects is based on Minecraft where students must rethink and redesign a public space in Maastricht. Since there is Minecraft for VR (we must see if

	educational licenses allow for that) VR could be used to collaboratively build the worlds but also have the final presentations within it. • There is a course in the MA Digital Cultures **Real Virtualities,** where VR could be used to have students reflect on the relationship between the physical and the real. ***Describe the UM-wide relevance for this project*** This EDLAB project directly supports UM's ambition to enhance education with technology that supports the unique PBL approach and learning principles. As illustrated by the pilot project examples from the different UM faculties, there already is momentum with much faculty-based experimentation taking place with VR in education; yet a UM-wide network that shared use cases, best practices, and resources – and is based on a holistic, structured approach from an educational perspective is currently lacking. Through this project, UM can position itself as a university that is at the forefront of digitally enhanced education, which further showcases the innovative spirit and approach towards education. It can further strengthen the PBL education internally and provide students with additional and different forms of feedback to improve student learning outcomes. The implications of this project would enable technology-assisted learning advantages for both student and staff, as well concrete guidelines on how to best integrate VR within PBL classrooms.

Deliverables and overall planning	**How will you plan your activities?** ***What deliverables does this project intend to achieve?*** 1. Initiate the establishment of a network of practice: Connect VR users and Digital Laboratories across faculties to share best practices with regards to VR enhanced PBL, specified towards UM, including EDLAB and UB as facilitators. 2. VR integration Guidelines: The aim is to generate concrete guidelines and practical examples, in the form of best practices and use case scenarios, of how to must successfully integrate VR training for presentation skills and 360 videos for academic skills training in our PBL classrooms. The goal is to have at least one practice example by each faculty of how they integrated VR for presentation skills or 360 videos in class. 3. UM Wide Event: Host a UM wide event to inform educators and course coordinators across faculties on how VR is currently being used and advertise the various digital laboratories to increase adoption of VR in PBL classrooms. The aim is to facilitate interfaculty exchange, in the hopes to develop more sustainable knowledge exchange and continuation of the project in the long run.

4. Initial Stakeholder Focus Group: Host a UM wide focus group with various stakeholders (e.g., students, tutors, coordinators, etc.) and especially non-VR experts to uncover perceptions and wishes for VR enhanced PBL in the future.
5. Scientific foundations background and analysis on VR education research in higher education: Consistently broaden the current research field of VR enhanced PBL by establishing "VR Experts" across faculties.
6. (Interdisciplinary) PhD position focusing on digital education as service[1] (intended, at the moment not part of the EDLAB project and not included in costs)
7. Aim for a central space offered by UB (potential deliverable): The aim is to leverage UB's knowledge on the creation and execution of centralized infrastructure (e.g., learning space, hardware etc.). UB could play a central role in providing teachers and students with access to 360 cameras and VR headsets to create videos for their PBL sessions.

Please give an indication of the overall planning, pilots and deliverables (e.g. work packages, duration, resources, customisation per faculty, etc.)

	2022				2023			
Deliverable	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Initiate Network								
2. Develop Guidelines								
3. UM Wide Event								
4. Foundation Research								
Pilots (supported by project)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SBE								
FASoS								
FHML								
FSE								

[1] The envisioned PhD position at the SBE (duration of 4 years) is separate from the budgeted cost at the end of this proposal. The PhD position is required to ensure long-term continuity of the idea to promote hands-on research on digital education innovation at UM.

	What needs to be prepared? - Research Plan - Initial focus group with diverse faculty representatives to establish view on VR enhanced PBL - UM Wide Event Specifications - Bi-Monthly user group meeting across faculties - 'VR-enhanced PBL' Best Practice Manual and Guideline (Final Project Deliverable) - Contact people on faculty level ***Training/documentation required?*** For the creation of the network of VR experts, no additional trainings are required. ***What support system(s) and service(s) do you expect to make use of to realise the project? (e.g. online tools, software, furniture)*** 1. Hardware: VR Headsets (Oculus Quest 2) 2. Software: dependent on activity 3. Location: digital laboratories across faculties 4. Sharing of news via UM marketing channels
Outcome	**Which concrete results do you expect?** ***How can the result(s) be measured? When can the project be assessed as 'successful'?*** The project will be deemed as successful if it brings to the creation of a self-regulating VR-expert network across faculties. The best possible outcome would be the creation of a network which aims to improve VR use within PBL classrooms, by sharing and facilitating best practices and learnings within their fields with other faculties and users. The continued implementation of the VR trainings beyond the project timeline would also show the success of this pilot project. The success of the event can be measured through show up rate. High interest for the event would signal institutional support for VR in education at UM. Last, success-standards of VR enhanced-PBL can be assessed through: • Level of implementation of VR across UM faculties • Student experiences and opinions • Willingness of teachers, course coordinators and educators to include VR activities in their courses ***Regarding the sustainability of results, which educational and technological services are needed to support implementation after the project?*** • Commitment from VR network participants to promote the inclusion VR activities within courses in their corresponding faculties.

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Faculty-based VR experts, responsible for the divulging VR-related information: training for staff, structural inclusion, digital laboratory management
Development of clear guidelines and best practice manuals to ensure the continued implementation of VR-based PBL activities within tutorials.
Institutional support by EDLAB to sponsor yearly VR-network events

</td></tr>
<tr><td>Budget</td><td>
Expected resources on top of standard reservations for developing and offering education.

Please describe the expected costs (people and facilities) per project element.
<u>Take into account the following</u>
*The budget for an EDLAB project can't exceed €50.000
*After liaison/PFO approval of the project proposal, EDLAB will internally conduct a financial feasibility check and reserves the right to decline the project proposal when the budget is not balanced. In this judgement both the financial feasibility of the project/pilot phase and steady-state realisation of the innovation will be taken into account

<table>
<tr><th>Name/Faculty</th><th>Task/Responsibility</th><th>Compensation</th></tr>
<tr><td>EDLAB</td><td>Project coordination</td><td>150 hours, in kind</td></tr>
<tr><td>Roberta Di Palma/
Dominik Mahr</td><td>Project Coordination/Project Leadership</td><td>120 hours</td></tr>
<tr><td>Faculty participants</td><td></td><td>Total of 400 hours, divided over project participants in relation to level of participation and input.</td></tr>
<tr><td>SBE</td><td>Working on deliverables</td><td></td></tr>
<tr><td>FASoS</td><td>Working on deliverables</td><td></td></tr>
<tr><td>FHML</td><td>Working on deliverables</td><td></td></tr>
<tr><td>FSE</td><td>Working on deliverables</td><td></td></tr>
<tr><td>FPN</td><td>Working on deliverables</td><td></td></tr>
<tr><td>LAW</td><td>Working on deliverables</td><td></td></tr>
<tr><td>UB</td><td>Assisting in implementation</td><td></td></tr>
<tr><td></td><td>Subtotal</td><td>670x €56, - = € 37,520, -</td></tr>
<tr><td>Student participants</td><td></td><td></td></tr>
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Project support by student assistance		100 hours
	Subtotal	100 x €13,- = € 1300, -
	Total in hours	730
	Total in Euros	€ 38,820, -
Additional costs		
Event		€ 7,200, -
VR Headsets + Software Try-outs		€ 3,980, -
	Total	€ 11,180. -
	Grand Total	**€ 50.000, -**
PhD position (not included in proposal)		**220k for four years**

** UD/UHD €56,- GPL*
*** OBP €42,- GPL // Student €13 ,- GPL*

Please sketch the financial implications for the faculties in case the pilot results lead to implementation

In case the pilot results in implementation, maintenance cost must be considered i.e., the different faculties could receive support in terms of lab maintenance and lab coordination/management.

Additionally, a “VR Expert” across faculties should be nominated to ensure upkeeping of network.