Innovative Pedagogy in Higher Education: Case Study of "Virtual Ward Design"

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CONTEXT

Technological advancements have brought significant transformations in educational practices, particularly affecting traditional components such as laboratories and field trips in higher education. These components are increasingly being supplemented or replaced by the growing adoption of virtual laboratories (VLs), reflecting the trend toward remote learning. A substantial body of research has examined the pedagogical implications of adopting VLs into educational settings, highlighting their beneficial effects on various aspects of teaching experiences.

PURPOSE

The purpose of this study is to investigate how virtual labs affects both the way lecturers deliver the lab and the way students experience learning within the coursework. This study contributes to the understanding of VLs' potential and the challenges in education, informing their effective implementation to enhance teaching strategies.

APPROACH OR METHODOLOGY/METHODS

We conducted an exploratory study to investigate our design of VLs. Guided by Dalgarno and Lee's (2010) framework we explored how adopting VLs affects lecturers' teaching experiences. Lecturers and students who used the VL in their course were invited to participate in this study. We employed interviews, observation, and student interviews to gather data.

ACTUAL OR ANTICIPATED OUTCOMES

VLs align with pedagogical approaches that promote experiential learning and engagement. However, VLs may struggle to fully recreate the interactive and personalised aspects of traditional, physical learning experiences. This study suggests that educators need to develop teaching strategies that effectively combine elements from both virtual and physical environments. These strategies aim to address the limitations of VLs by finding ways to enhance interaction, personalisation, and engagement within virtual learning contexts, ultimately optimizing the learning experience for students.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

While VLs hold promise for fostering collaborative and experiential learning, they also present challenges such as technical barriers, students' unfamiliarity with VR technology, and high cognitive load. These challenges can affect the effectiveness of both teaching and learning. The study recommends integrating VLs with physical field trips to overcome these challenges and enhance the overall learning experience.

KEYWORDS
Virtual Labs, Innovative Pedagogy, Learning Experience

Introduction

Innovative educational elements such as virtual laboratories and virtual field trips are increasingly being adopted, complementing or even replacing traditional laboratories and field trips due to the integration of new technologies and the shift towards remote learning in Higher Education Institutions (HEIs) (Glassey & Magalhães, 2020; Watson et al., 2023). Virtual laboratories (VLs) fall under the broader concept of extended reality (XR), which involves creating immersive and interactive digital replicas of the real world (MacCallum, 2022). VLs are specialised forms of virtual learning environments designed to support practical learning activities within digitally simulated settings. The term VLs specifically highlights the capability to conduct experiments and practical activities in virtual settings. These laboratories can generate a wide range of 3D simulated environments for learners to explore firsthand, allowing users to take on different roles, interact with objects, and experience a strong sense of presence (Riva & Waterworth, 2014).,

VLs provide educators with opportunities to implement innovative pedagogical approaches, supporting experiential learning (Pande et al., 2021), contextual learning (Liu et al., 2017), and collaborative learning (Southgate et al., 2019). VLs enable educators to create dynamic and interactive teaching environments, making them valuable tools in higher education for developing effective and modern teaching strategies (e.g. Chen & Hsu, 2020; Suri et al., 2023; Yudintseva, 2023). By integrating VLs, educators can enhance various teaching strategies that foster student engagement (Chen & Hsu, 2020; Marougkas et al., 2023) and promote cognitive development (Pande et al., 2021). Although VLs provides many educational benefits, but it also has drawbacks, such as increasing learners' cognitive load and technical disruptions (Patiar et al., 2020; Manuri, & Sanna, 2016). Also, developing VL components is costly and time-consuming, and rapid technological advancements can make VLs quickly outdated or obsolete (Parsons & MacCallum, 2021).

The purpose of this study is to explore how adopting VLs influences lecturers' teaching strategies and overall teaching experience. We also will examine how this shift could influence students' engagement, experiential learning, contextual learning, and collaborative learning. As such, this research question guides our study and help us to understand the implications of this transition for both teaching and learning: How does a transition from physical laboratories to a virtual one affect lecturers' teaching?

In this study we draw on Dalgarno and Lee's (2010) model for virtual learning environments. This model was developed to inform VL designers, however, we draw on this model to frame our findings on how adopting VL influences aspects of teaching. It is important to note that this paper represents part of a research project on how VLs influence students' learning experiences and lecturers' teaching practices. This article specifically focuses on two elements of the Dalgarno and Lee's (2010) model: collaborative learning and contextual learning.

Context

Previously, before this specific VR laboratory was developed, students undertook a physical workshop field visit to the Canterbury District Health Board (CDHB) 'Design Lab'. The 'Design Lab', which focused on human-centred design and design thinking, hosted extensive artifacts of the design processes, including life-size prototypes, documents, photos, and posters affixed to several walls and panels around the large open space. Over the years, this space also served as a teaching resource for students to explore these artifacts for their ward design projects. However, the CDHB decided to decommission the design space in 2022, making it unavailable for teaching purposes.

In response, course coordinators took the initiative to gather 360 degree video and photographic material with the assistance of specialised staff preserving the essence of this space and enabling students to delve into the design processes involved, including the design process used to build the new Waipapa' ward at Christchurch Hospital. The videos were all filmed in an interview style, where lecturers in the course interviewed CDHB employees while they explored the artifacts and discussed the innovation process used at the design. The videos were filmed using 360° cameras. The artifacts (Figure 1) were photographed using a standard camera and then the photos were processed using stereo-from-motion photogrammetry software (Agisoft Metashape) to create digital doubles. On top of these resources, additional video and photography from the ward design process were also used in the virtual lab, e.g. one of the course lecturers went to film a walk-through in the completed ward using a 360° camera. This virtual lab called **'**Virtual Ward Design**'** was created to preserve the educational benefits of a field visit to the CDHB 'Design Lab'.

Figure 1: Artifacts on the wall including videos, photos and documents.

The 'Virtual Ward Design' were created with the following learning outcomes:

1. Gain a comprehensive understanding of applying a design approach to creatively address complex problems.

2. Develop an appreciation for the fundamental principles underlying a design-focused approach to innovation.

3. Recognise the value of embracing visual techniques that combine both analogue and digital tools, facilitating more diverse and collaborative problem-solving approaches.

The **'**Virtual Ward Design**'** was introduced to the students in a similar fashion for the courses in A, B, and C, during a lecture session towards the second half of each course:

- MBA 'Innovation by Design' (course A)
- Business Taught Masters course 'Innovation' (course B)
- Speech and Language Therapy course 'Innovative Practice Project' (course C).

Students were first introduced to the 'Design Lab' context by the course lecturers and scaffolding on design process concepts was provided if required (e.g. course C had less experience with the design process). The students were then introduced to the lab using an online video on a screen that explained how to interact with the virtual lab, including how to navigate using the VR headsets. Students were divided into group of max 12 and each group took a turn using the headsets for 20-30 minutes, rotating with other activities of the course.

Table 1: Interviewed participants information

Pseudonym	**Course**	**Type of interview**
Lecturer A	A	Individual

Lecturer B	B	Individual
Lecturer C	C	Individual
Student 1	C	Group
Student 2	C	Group
Student 3	C	Group
Student 4	B	Individual
Student 5	B	Individual
Student 6	B	Individual
Student 7	A	Individual
Student 8	A	Individual
Student 9	A	Individual

Research design

Dalgarno and Lee model

Dalgarno and Lee's (2010) model explores the benefits of three-dimensional (3-D) VLs, identifying unique characteristics that can guide VL designers. These characteristics include spatial knowledge, experiential learning, engagement, contextual learning, and collaborative learning (Figure 2). In this study, we use this model to understand how adopting the 'Virtual Ward Design' impacts these characteristics and influences various teaching aspects.

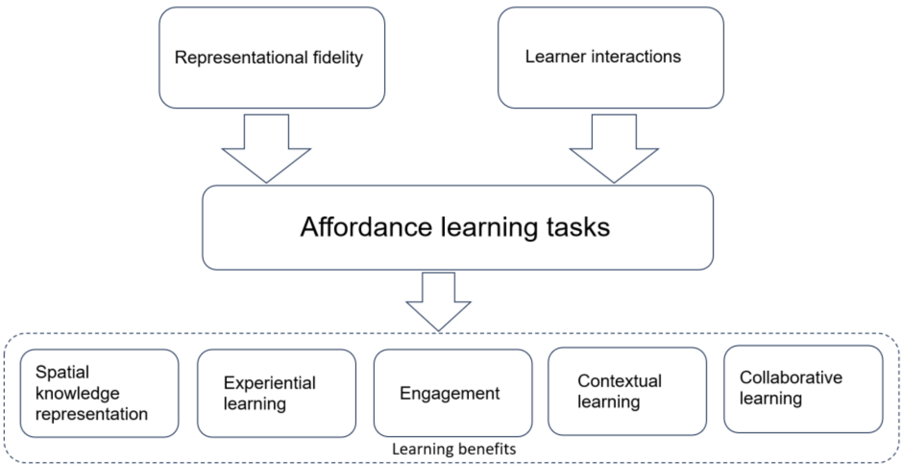

Figure 2. Model of learning in 3-D virtual learning environment (source: Dalgarno and Lee, 2010, p.15)

Participants, data generation and analysis

In this study, qualitative research methods were employed to explore our research objective. This approach involves open-ended investigation including different means of data generation. For this study we employ semi-structured and grouped interviews. This research was conducted in accordance with ethical guidelines and has received ethics approval from University of Canterbury human research ethics committee, under approval number HREC 2023/55.

This study included interviews of three lecturers who used the ‘Virtual Ward Design’ in their course as well as nine students who were enrolled in these courses (Table 1). All the students in this course were involved with using the ‘Virtual Ward Design’ as part of their course and were subsequently invited to participate in the study. Two weeks prior to the data collection, students were briefed on the research's objectives, their potential participation, and received information regarding ethical considerations. The interviews were semi-structured and covered three main topics: motivation for using VL, challenges encountered when adopting VL, and potential benefits of integrating VL into other courses. The lecturers also shared their personal reflections on the VL experience and their insights on its broader applicability. In this study, we analysed the data by identifying patterns and insights through thematic analysis, which lead to developing initial codes from the data. We also used Dalgarno and Lee (2010) model to develop the final themes.

Findings and Discussion

The insights gathered from interviews and observations highlight a significant emphasis on student interaction not only with VL components but also among students themselves and between students and lecturers. The forthcoming sections delve deeper into these findings, underscoring the crucial role of interaction and instruction in effectively utilising VLs in teaching strategies.

Collaborative learning

Collaborative learning is about acquiring knowledge through interaction with one another. Learners actively build their understanding through engagements with others, including lecturers, instructors, peers, and subject matter experts. Collaborative learning places emphasis on the social and cooperative dimensions of the learning process (Vygotsky & Cole, 1978). According to studies, VLs holds the potential to facilitate collaborative learning among students, because within a virtual environment, learners can also have the opportunity to collaborate on projects and tackle problems collectively. They can also participate in discussions, much like they would in a traditional physical classroom setting. This collaborative element is considered highly advantageous for the overall learning experience (Southgate et al., 2019).

In this study, lecturers and students discussed several aspects of collaborative learning in the context of the “Virtual Ward Design”. Both lecturer and students highlighted the value of student-student and student-lecturer interaction and collaboration, discussions, and sharing observations during virtual trips, similar to physical lab or field trip experiences.

Lecturers mentioned the importance of providing opportunities for questions and discussions between students and lecturers. Two lecturers emphasised that not having the interaction with students in virtual environment may lead to lack of evaluating how students are engaging with the VL. They pointed out if they had the ability to observe their students body language and expressions, while they are exploring the virtual environment, they could be more responsive. They mentioned tracking the students' activities such as questions and comments, particularly the areas where they spent the most time, which can provide insights into their interests and engagement:

> *something that was a little easier in person is that you can see what's drawing the student’s attention, whereas we weren't (in the VL experience) because we weren't casting everyone's VR. We needed to wait until after when they came out of the VR to talk to them about what was interesting or find out what questions they had (Lecturer C)*

Also, lecturer A referred to the possibility of incorporating a question mark button or a feature like a "confusion flag" in future virtual experiences. This feature could allow students to easily indicate when they have questions or are confused about certain elements during such virtual activities. This would help enhance the learning experience and address students' uncertainties more effectively.

Five students mentioned the potential for peer interaction and discussions during a virtual trip, which is currently not implemented in the VL in a way that would happen during physical field trips.

> *Well, actually I would prefer a physical experience. I feel that there's more interactivity that way (Student 1)*

> *I think I would prefer the other one [physical field trip], because that personal interaction is very important for me, even though with this I did not miss out on the content (Student D)*

Two students expressed their preference to share observations and discuss their field trip experiences with classmates in the virtual environment, similar to what they would do on a physical field trip. This is reflected in below statement:

> *I think when we talk to others, there's lot of learning from their experience and what they feel and not just what we see but when we talk to each other, there's a lot of exchange of knowledge which I which I would appreciate more (Student E)*

One student also pointed out the limitation of interacting with the lecturers in the virtual environment. She believed that in the virtual field trip, she did not have the opportunity to directly communicate with the lecturer or ask questions. Four students in this study suggested the combination of VL and physical field trips would be helpful in terms of collaborative learning.

Contextual learning

The model by Dalgarno and Lee (2010) underscores the role of VLs in fostering these real-world experiences which can lead to the transfer of knowledge and skills from the virtual realm to practical application in the real world. This also allow students to explore and learn in ways that are difficult or impossible in the real world. This is because VLs can simulate dangerous, expensive, or physically impossible scenarios (Liu et al., 2017).

Participants discussed how VLs play a crucial role in creating a learning environment which can lead to learning in the context and transfer of knowledge. Both lecturers and students pointed that the adoption of 'simulated scenarios' could provide students with a safer learning environment. A lecturer highlighted the significance of prioritising the emotional and psychological safety of students throughout their skill development journey. They suggested that VL experiences could offer a safer and less intimidating environment for students, providing hands-on practice without the pressure or fear of making mistakes. This is also reflected in student interviews. Two students mentioned the potential use of VLs to prepare students, particularly in medical or client-facing roles, for handling emotionally challenging situations or conflicts such as dealing with upset clients or challenging emotional reactions, in a controlled and safe environment. This provides a learning experience that allows students to practice managing their emotional reactions and responses before encountering similar scenarios in real-life settings. They highlighted that as students they have limited chance of experiencing situations involving conflict, but VLs can develop professional careers without risking safety or violating health protocols.

> *Another scenario I feel it may be useful is like …dealing with conflict…you could actually have some scenarios where someone is (client or patient) getting upset or something's happening, like vomiting, that is causing you know, is potentially a difficult situation to deal with. VR is to provide a platform for practitioners to practice and develop their emotional reactions and coping strategies in a controlled environment before facing such situations in real life. (Student C)*

Lecturer A pointed out that certain environments within industries could provide valuable experiences for students. However, due to health and safety concerns, these opportunities are often restricted. Therefore, adopting VLs could create a safe setting for students to gain industrial experience. He mentioned using a 360-degree camera to capture the content during visits to places like factories, indicating a potential innovative solution to bring these experiences back to the classroom for students who might not have the opportunity to physically visit these locations.

Our research revealed that while VL experiences may not offer direct contextual learning—such as providing learning specific details about an environment—they provide opportunities for students to navigate difficult situations without the added stress of real-world safety concerns. In other words, lecturers could use VLs in the classroom to create a focused learning environment that minimises safety-related distractions, allowing students to concentrate more effectively on developing their professional skills.

Conclusion

Our study showed that “Virtual Ward Design” project has the potential to promote collaborative learning among students. Both lecturers and students recognised the value of interaction and collaboration in the virtual environment. However, Lecturers highlighted the need for improved mechanisms to track student engagement and suggested adding features to better facilitate real-time interaction and response during VL experiences. Also, several students emphasized the importance of peer-to-peer knowledge exchange and direct communication with lecturers during VL activities.

This study recommends further research and design efforts to improve VLs in fostering collaboration between students, as well as between students and lecturers. For instance, conducting debriefing sessions post-virtual lab activities could address issues related to interaction. This aligns with existing research indicating that VLs can effectively prepare students for physical field trips by providing interactive, informative, and engaging experiences that enrich the overall learning process (MacCallum & Parsons, 2022; Zakaria & Wilkie, 2020).

An alternative approach to adopting VLs is to offer the virtual experience after the physical lab or field trip. Harron et al. (2019) suggested, this strategy could motivate student recollection of the experience. This is also in line with contextual learning, where newly acquired concepts seamlessly blend with existing knowledge. Students who possess a broader context of a subject can grasp new information more swiftly and comprehensively (Kolb, 2015).

Our research revealed that VLs enable students to practice and apply their skills in scenarios mirroring real-world contexts (Guo et al., 2016). Students in our study highlighted the use of VLs as a preparatory tool for critical situations, such as those encountered in hospital settings. Dalgarno and Lee's model (2010) emphasises the pivotal role of VLs in facilitating these contextual learning and lifelike experiences, aiding the transfer of knowledge and skills from virtual environments to practical real-world environment. However, some students noted a negative impact on the experiential learning benefits of VLs. They felt that the virtual environment restricted their freedom to explore and roam as they would during a physical field trip. This limitation is attributed to the pre-designed nature imposed by the creators of the VL.

It should be noted that the primary aim of this ‘Virtual Ward Design’ was not research-oriented; the lecturers used the ‘Ward Design’ lab in virtual reality because the physical lab was not available. Consequently, we could not observe or interview students with experiences in both physical and virtual labs. Matovu et al. (2023) argue that when the design of a VL is not fully controlled by researchers, there can be a misalignment between the activities and the research goals. They suggest that additional activities, such as pre- and post-assessments, may be needed to address this misalignment. For future studies, students can be questioned in an assessment regarding the extent of their learning from the VL experience and how effectively they apply the knowledge acquired in the VL. Also, future studies could compare two groups of students: one group with experience in the physical lab and one group with experience in the virtual lab.

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