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Teaching in Virtual Reality: Experiences from a Lean Masterclass

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Abstract. Virtual reality offers an immersive, remote alternative to in-person teaching. We teach a Lean masterclass entirely in real-time virtual reality. By summer 2021, we had taught five masterclasses for 117 senior-level managers from more than 50 leading organisations. In these courses, participants located all over the world can interact with each other almost as in a physical seminar setting. Drawing on formal course evaluation surveys and personal experience, we discuss the appropriateness of real-time virtual reality as a teaching platform and the benefits and challenges of this approach. Based on our experiences, and taking into account the rapid ongoing technological development, we imagine that this form of teaching and learning will accelerate in importance and application.

Keywords: Immersive teaching, immersive learning, virtual reality, metaverse, Oculus, Lean

1 Introduction

The COVID-19 pandemic made in-person teaching difficult, and, for courses with international participants, impossible. Since March 2020, there has been a surge in the quest for remote access technologies for both everyday work and education. Virtual reality (VR) is one such technology that has been proposed due to its ability to connect people without the need for travelling and because it can provide an enhanced learning experience [1]. This paper is the first to report experiences of teaching a business concept such as Lean in a real-time, immersive VR platform. Rather than studying how to teach Lean *with* VR [2, 3], we study how to teach Lean *in* VR, which is totally different.

We have worked with The Leadership Network (TLN) in teaching a masterclass called ‘Intelligent Lean’ in their state-of-the-art, real-time VR platform called ‘Gemba’ [featured in 4, 5, 6]. In Gemba, participants meet in real time as avatars in an immersive virtual environment and interact much as they would in a classroom or seminar. Based on the first five teaching events with participants from all over the world, we discuss pros and cons and how we see the future of this type of VR for business education.

To inform our discussion, we draw on our own experiences, feedback sessions during the masterclasses, and feedback surveys from the masterclass participants. After each masterclass event, the teachers and TLN representatives organised debriefing sessions and reflected on how to improve the technical VR environment, the content taught and the teaching process. To rule out self-bias and provide a robustness check of the findings presented in this paper, it has been reviewed and commented on by other masterclass teachers and previous masterclass participants.

Judging from the self-reported learning experience of participants and our own experience as teachers, we conclude that real-time, immersive VR is well suited to teaching Lean and other business curricula. The technology is available and effective, but the technical and administrative efforts required to implement it should not be underestimated. VR education has fundamental advantages, such as cutting travel time, budgets and CO₂ emissions to the minimum. We predict that future education will very soon see increasing use of real-time, immersive VR platforms. We have barely experienced the emergence of this technology.

2 Immersive Teaching with Virtual Reality

According to a definition by NASA, ‘Virtual reality is the use of computer technology to create the effect of an interactive three-dimensional world in which the objects have a sense of spatial presence’ [7]. VR is a computer-generated 3D environment that users experience as close to real. While other studies use a more relaxed definition of ‘VR’, including virtual computer games (in 2D or 3D) [e.g. 8, 9], we refer in this paper to technologies that are ‘fully’ immersive in the sense that they require VR headsets and give the user an impression of being somewhere else. The virtual environment can be virtual copies of a real-life context (captured via 360° footage or photos) [e.g. 3, 10, 11], a fully virtual, computer-generated environment (resembling or not resembling a real-life context) [e.g., 12] or a mix of the two. The VR environment can be ‘offline’—without real-time interaction with other users—or ‘online’ with real-time interaction.

VR has previously been explored as an element of Lean teaching in a small number of cases, including offline applications at ETH Zurich lead by this paper’s first author [2, 3, 13]. The ETH Zurich applications involve immersive experiences in which students are provided a recorded VR environment of real factories as part of their course. The students actively explore the virtual content guided by assignment questions. This was initially done through open-access, 360° VR archive material from ABB factories [3], then 360° VR material from YouTube including a Toyota factory [2] and most recently with 360° VR material developed in partnership with the Hilti Corporation [5]. These applications are examples of teaching Lean *with* VR.

VR technology has recently had technological breakthroughs. For example, the first versions of the VR technologies Oculus Rift and HTC Vive, shipped in 2016, and Oculus Quest shipped in 2019. In August 2021, Facebook launched ‘Horizon Workrooms’, a VR workspace accessible with Oculus and part of the company’s strategy to develop a ‘metaverse’ where people can be ‘inside the internet’ [14]. Due to such recent advancements, and accelerated by the COVID-19 pandemic, VR now offers

opportunities for immersive real-time, human interactions in a virtual environment for conferencing, meeting, lecturing and gaming. Yet, due to the novelty, the literature offers no reports on teaching Lean or other business concepts *in* VR. This paper addresses this gap.

3 Teaching Intelligent Lean in TLN's Gemba Platform

We use a platform called Gemba designed, managed and marketed by TLN. This platform has received considerable press coverage, including features in *The Financial Times* [5] and *Forbes* [e.g. 4, 6] among other high-profile publications. Gemba won the 'Best Use of VR/AR' in the 2020/21 Go:Tech Awards.

The authors lead a masterclass entitled 'Leading Intelligent Lean'. The origin of the course was a three-day physical course that was planned for delivery at a factory site in Germany in April 2020. However, it was not possible to run this course due to the COVID-19 outbreak. The course was switched to the VR platform that had already been in development by TLN as an offering separate from their physical courses. By summer 2021, the VR Lean masterclass had been organised five times. It is an executive masterclass delivered over five half-day sessions almost exclusively through VR.

To give an impression of how Gemba looks and works, Fig. 1 a–d shows four different VR environments in Gemba (as of spring 2021).

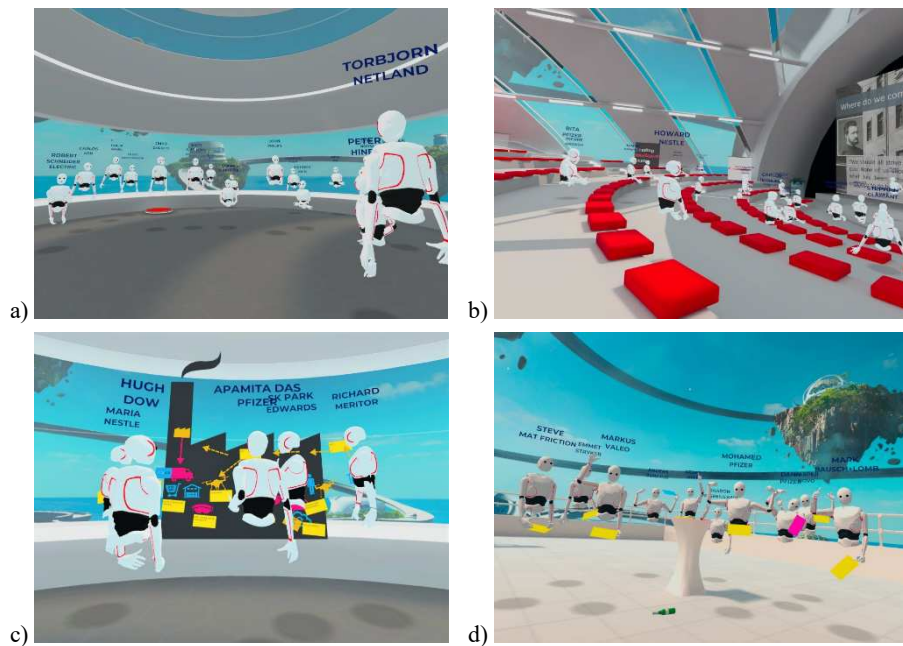


Fig. 1. Snapshots from the Lean Masterclass in the Gemba app

Fig. 1a shows the avatars of the teachers and participants in a breakout room. Fig. 1b shows the lecture of an external industry speaker in an auditorium. Fig. 1c shows group work in a breakout room using virtual yellow notes and icon stickers on a factory-shaped black board. Fig. 1d shows a 'sky bar' used for networking and quiz games. The participants—all wearing Oculus headsets at their locations around the world—act as their own avatars and can hear, see and interact with the other participants in real time. A typical masterclass has around 25 participants.

The masterclass 'Leading Intelligent Lean' is split into five half-days of a week. This schedule is easier on the eyes than spending full days in VR and allows the busy participants to handle other responsibilities during the week. We teach and discuss how Lean concepts evolve with the advent of the fourth industrial revolution and how to lead transformational change. Typical participants are C-level and senior-level managers and transformation leaders. The course is organised in the afternoon on European time to also allow participants from the Americas and the Far East to attend (albeit at partly inconvenient times). The entire course is taught in VR, with some extracurricular activities during regular video conferences (e.g., participant introductions, continuous helpdesk and discussions on topics of special interest).

In this course, we define Intelligent Lean as 'making the most of human intelligence and digitalisation in support of sustaining the Lean end-to-end transformation'. The course is carefully designed as a mix of frontal lectures from the leaders and invited guest speakers, group breakout sessions, ideation workshops, reflection sessions and networking (e.g., quizzes). Overall, the course design has similarities to that of a physical classroom setting, but the administration, delivery, facilitation and content are tailored to the opportunities and challenges of current state-of-the-art VR technology.

4 Feedback and Experiences

After each course, a detailed feedback survey was distributed to the participants. The survey asked participants to score the masterclass, leaders, guest lecturers and the administration and organisation. It also requested open feedback on challenges and opportunities. Overall, 81 of the 117 participants completed the feedback form (a 69% response rate). Together with TLN, we actively used this feedback to improve the course incrementally for every instalment.

Due to the novelty of the topic and the fast-moving nature of the technology, we present here primarily the reactions of the participants (i.e., reports of the learning experience). The overall feedback and our experiences suggest that participants were very satisfied with the course content and delivery. The median course rating—as well as the scores for most of the evaluated categories (presentations, content, technology, etc.)—is 8/10, which is in the range of high-scoring physical TLN masterclasses before COVID-19.

Mirroring the positive feedback relating to learning experiences, VR also works surprisingly well for teaching. Teaching can be done from any silent room with wireless internet access. However, special preparation was required to adapt presentation slides to a VR-friendly format before uploading them to Gemba. Because current VR

technology makes quick personal coordination between event organisers and lecturers difficult (everyone in the same place would hear it), we communicated via a messenger service on our phones. This allowed us to make quick decisions and adjust the program as needed. After each masterclass, we reflected on and discussed personal observations and notes that we had recorded during the class. We used this to improve the masterclass step-by-step by adapting the program and platform accordingly.

5 Discussion and Outlook

Is VR an appropriate platform for teaching Lean? We conclude that it is. Obviously, it is not sufficient on its own. Learning Lean requires actual observation and interventions in real-life processes. However, as a replacement for classroom teaching, VR now works very well. We could run virtual exercises and breakout rooms, use post-it notes and hold ‘classroom’ lectures with Q&A sessions without problems. Table 1 summarises the main advantages and challenges regarding teaching in real-time VR we have discovered.

Table 1. Advantages and challenges of teaching in real-time VR

Advantages	Challenges
No travel time or budget	Requires a VR platform and headsets
Minimal CO ₂ emissions	Technological limitations
Pandemic-safe	Less ‘watercooler moments’
Full immersive learning, no distractions	Very limited human body language
Inspiring VR environments	Required preparations of leaders and material
More equality (all look the same in Gemba)	Less personality (all look the same in Gemba)
Use of new technology gives ‘wow effect’	New technology for participants to learn
Ease of use (Oculus and Gemba)	Weight and heat of VR headset
Affordable (Oculus Quest 2 costs USD 300)	Difficult to take notes while in VR
Enable blended information and 3D models	Potential cybersickness/tiredness
Enable computer-based gamification	Limited pedagogy available for VR teaching

5.1 Advantages of teaching in real-time VR

As listed in Table 1, one set of advantages relates to the time and space dimension. VR has obvious advantages when it comes to bringing people from all over the world together quickly without the need for travel or the risk of spreading infectious diseases. This reduces travel time, travel costs and environmental footprints – all very important metrics. Considering the participant locations of the first four courses, we calculated the average CO₂ savings per participant to be about 1,000 kg from flights not flown [based on 15]. This corresponds to approximately 10% of the annual CO₂ footprint of an average UK citizen (lower percentage for a US citizen, higher percentage for a Swiss

citizen) [cf. 16]. In the five first courses, we had participants from more than 20 countries (including, Brazil, South Korea, the USA, the Philippines, India, the UAE, and many European countries).

A second set of advantages relates to the immersive aspects of VR technology. Participants appreciate that the fully immersive experience allows them to be fully focused on the content and exercises (in contrast to checking emails or phones during an in-class lecture or video conference). They enjoy the immersive learning in the VR platform and how ‘extraordinary’ or ‘remarkable’ the experience was. Half of the participants explicitly noted this in the open area of the feedback survey. Many also emphasised that it was ‘fun’ and ‘exciting’. A legitimate question is whether this form of positive technological enthusiasm will remain, increase or diminish as VR and ‘virtual fatigue’ become more commonplace. For most of our participants, this masterclass is their first experience in real-time VR.

Thirdly, many advantages stem from the technological opportunities (and limitations). For example, in this course, we use neutral, identical avatars. This makes everyone equal and removes distractions and personal biases associated with physical appearance (which are not to be underestimated in physical lectures or – perhaps even more so – in online conference platforms where one constantly sees oneself). We also noted that listening rates tend to be higher in VR than in real life, simply because there is not much more to do than listen (e.g., no emails, no smartphones). We also note that the technology is affordable (Oculus headsets are selling at USD 300) and easy to use and learn with some assistance. VR enables blended information and 3D models to be shown anywhere, which is an advantage over classroom teaching. VR allows building imaginative worlds that can inspire participants to think beyond the restrictions of the real world. This year, TLN has also integrated 360° factory visits in their VR platform by using recorded VR footage from a Toyota factory in the UK.

5.2 Challenges of teaching in real-time VR

VR also has several limitations. Obvious limitations relate to the technology. Teaching in VR first requires an online platform (e.g., Gemba) and VR headsets present at all participant locations. All participants must have access to high-speed wireless internet. Because installing VR software on the headsets is still cumbersome, this was done by TLN in our case. TLN shipped and collected VR headsets to participants around the world using a third party logistics provider. This is a logistical and administrative challenge. In addition, all material must be in a VR-friendly format (e.g., large font and toned-down colours).

From a pedagogical point of view, a real challenge is the lack of human body language and few opportunities for serendipitous ‘watercooler’ discussions. This limits both direct feedback from the students and the overall experience of the participants. The neutral look of the avatars also reduces the potentially positive influence of a charismatic or lively individual, although some of these characteristics will be transferred via voice. It is also a limitation that participants cannot currently take notes in TLN’s VR platform, a problem Oculus recently developed a fix for.

Many participants reported tiredness, and some reported cybersickness, especially during the first days in VR. Our own experience suggests that cybersickness diminishes with practice. All these technical challenges are likely to be reduced with future developments in VR technology.

Virtual fatigue is perhaps the greatest challenge for teaching in VR. As VR becomes more commonplace, participants will sharply raise their expectations. Therefore, we expect that a blended teaching approach will be most effective. Figuring out where VR has its definitive edge over classroom and online teaching, is still subject to experimentation and research.

6 Conclusions

This paper discussed the opportunities and challenges related to teaching a course entirely in real-time, immersive VR. We showed that this form of teaching generally works well and is developing rapidly. Taken together, we summarise the following four propositions:

- P1. Real-time, immersive VR is a viable and available alternative to classroom and online teaching.
- P2. Real-time, immersive VR will accelerate as a future teaching mode.
- P3. Real-time, immersive VR is best used as part of a blended teaching approach.
- P4. Real-time, immersive VR will require and foster new teaching pedagogy.

Although we have attempted to be comprehensive in our reflections, we see this paper as solely exploratory. We have only reviewed one course; we have only explored one VR platform (TLN's Gemba); and we have only used one type of headset (Oculus Quest). In addition, we have not collected longitudinal information from participants in the months after the course to test their learning outcomes. These shortcomings leave ample opportunity for future research into what is certainly a disruptive technology that educators must consider for future use.

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