WARWICK
THE UNIVERSITY OF WARWICK

Kickstart VR at Warwick

Project Report

Investigating the role of Virtual Reality in Higher Education.
Stimulating experimentation and design thinking with VR.
Discovering how to support VR for enhancing
learning, teaching and the student experience.

Dr Robert O'Toole NTF with support from Catherine Allen (catherineallen.uk)
July 2017
Funded by Santander Universities

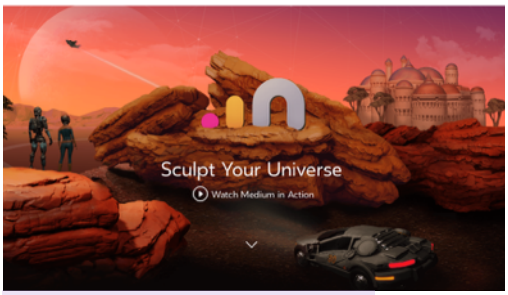
“Be not astonished at new ideas; for it is well known to you that a thing does not therefore cease to be true because it is not accepted by many.” Baruch Spinoza, *Short Treatise on God, Man and His Well-Being, c.* 1660.

Contents

1. Definitions

Virtual Reality (VR)

A combination of video and audio, filling a single person's field of sensation, that works with their perceptual process to give the illusion of being in a computer generated, and yet believable, reality. As the participant moves their head around the visuals (and sometimes the audio) changes naturally to give the sense of being in a real world. VR may also provide physical feedback through touch surfaces, tactile interfaces allowing objects in the virtual world to be manipulated, and haptic feedback between manipulated objects and the body of the participant. VR experiences are usually undertaken individually, however in the future social VR will be more common, with people able to interact with each other.



Oculus Medium, tactile interactive VR

Binaural Sound

Audio recorded and played back in 3D, with responsiveness to the movements of the participant. This achieves the deepest degrees of immersion. Sound design is a key factor in the effectiveness of VR.

Microsoft HoloLens (@ Microsoft)

360º video

Special video cameras can record video as a near continuous 360º image. This may then be viewed through a VR headset. With current technologies very little interactivity is possible in such videos. Viewing is a more passive experience.

Augmented Reality (AR)

Not to be confused with VR. In this case a screen, a headset or a visor is used to overlay digital 3D images onto the user's view of the real world. AR has a very different purpose to VR. Microsoft HoloLens is an AR system.

Room-scale VR (@ Deposit Photos)

Untethered Virtual Reality

The Oculus Rift and first generation HTC Vive systems use a headset that is conncted to a powerful PC using cables. This restricts the physical movement of the participant. HTC Vive does have a system of sensors that will track the movement of the participant around a space, and map that onto their movement in the virtual world. Future versions of these systems will be "untethered" allowing greater mobility and multi-person VR. Microsoft's HoloLens is an untethered AR visor.

Lo-fi and Hi-fi Virtual Reality

VR systems range from hi-fi headsets like the Oculus Rift, down to lo-fi systems like Google Cardboard, which use an ordinary smart phone placed in a cheap headset. Samsung's Gear VR is a mid-fi option, using an expensive Samsung phone. These phone based systems are effectively "untethered" but do not as yet support sophisticated movement tracking.

Exploring lo-fi VR (Peter Marsh at ashmorevisuals)

Tactile and Haptic Virtual Reality

The more sophisticated systems include hand-held controllers that allow the user to manipulate objects in the virtual world. Haptic controllers provide physical feedback to simulate touching virtual objects.

2. Introduction


© Deposit Photos

By Dr Robert O'Toole NTF, project lead.

My first encounter with Virtual Reality at Warwick, indeed the first time I heard about it anywhere, was way back in 1995 at an interdisciplinary conference for futurologists. The World Wide Web had just arrived. In 1993 we had built the Philosophy Department's first web site. The talk I gave at the conference was, unbelievably, streamed out onto the Internet, most likely to a tiny pioneering audience prepared to put up with a stuttering low resolution transmission. So many things seemed, and proved to be, possible. Within such a small time span computers shrunk down and became many thousands of times more powerful.

Phones became mobile, minituarised, got the internet, went smart, suddenly grew-up again into the tablet computer, and gave us ubiquitous computing connected anywhere and everywhere.

And yet what happend to VR?

Image libraries have contained photos depicting people lost in VR (see above) for many many years before the technology bacame a reality.


© BBC

Only in the last couple of years have we seen the arrival of affordable devices with acceptable quality. And even more novel, there's actually now a good selection of content to play on them. A new creative profession is forming to enable this, as people learn about what works well and what doesn't, bringing practices from film, gaming, theatre, science and education into a new synthesis. A transdisciplinary synthesis producing exciting new kinds of experience (as with the BBC's Easter Rising, above). And potentially, a new kind of education, or at least new possibilities for education.

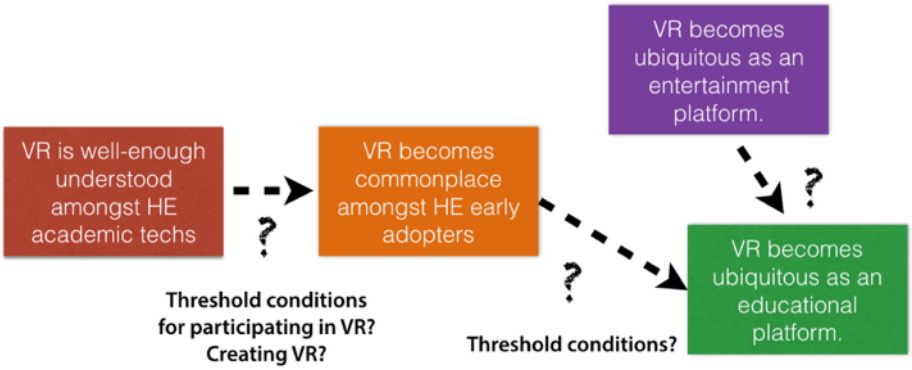
This project represents the beginnings of our work to explore the possibilities.

Enjoying a virtual trip to Monash University, Australia (Photo: Peter Marsh at ashmorevisuals)

3. Project Aims

The project began with four aims:

1. **Stimulate VR based activity** and the formation of a network of practitioners at the University of Warwick - *an email-based discussion group has been created, with members from across the University, however the VR community at Warwick is small, and* ***further work will be needed to sustain and expand the group***;
2. **Prompt discussions around the application and value of VR** for enhancing learning, teaching and the student experience - *achieved through the workshops, the email list and presentations at learning and teaching enhancement events - t****his is an ongoing process which will need further support*****;**
3. **Identify the "threshold conditions"** that must be passed in order to see VR (use and creation) becoming commonplace amongst early adopters, and eventually ubiquitous as an extension of our educational platform (not meaning that it becomes the main platform, but rather that it becomes just an ordinary tool within the wider repertoire we commonly use) - *this was achieved through the workshops and through the evaluation of VR production techniques, including 360 cameras, and* ***we can now specify the conditions necessary for more widespread adoption, see findings (page 10)***



4. **To understand how developments outside of education, especially in the entertainment industry, might impact positively or negatively on VR in education** - *achieved through tracking news via the 360 Rumours web site and other sources, this is as yet an uncertain and fast evolving dimension of the project.*

This diagram illustrates the core challenge we addressed (points 3 and 4 above).
With high levels of investment coming into VR from entertainment-oriented companies like Google, Samsung and Facebook, education will most likely continue to be a low priority, being a more complex domain from which profit may be extracted. Entertainments of various forms may well act to push educational applications down below the horizon. There is also the possibility of a widespread negative reaction to VR, if we see the entertainment (especially games) industry push hard for its application in more aggressive genres. We could be seeing the beginnings of the kind of moral panic that sometimes accompanies radical new technologies (Allen, 2017). We therefore want to do something to counteract these tendencies before it is too late.

In addition, when we considered the influence of a gender and culture biased tech industry, a fifth aim quickly emerged once we began the project:

5. To investigate and to actively promote VR as a tool for widening participation and promoting diversity, both in higher education and in the technology industry - *we ensured a gender balanced group, including leadership by a female technologist, and we ensured that a disabled student actively participated, allowing us to see the value of VR in widening access to educational experiences and activities -* ***we would like to follow this up by supporting the creation of 360 films to support disabled students and to address inclusivity and diversity challenges.***

4. Academic and Professional Contexts

VR experiences, such as the BBC's *We Wait* (2016), can have a deep emotional and intellectual impact on participants. We are only just starting to understand the nature of this new reality. So how can we start to understand its fit with learning and teaching in the University?

Teaching is hard. Becoming a good teacher in a discipline takes time and a great amount of effort. And there is often great uncertainty along the way. What works for one teacher may prove a poor fit for another. There is a great deal of individual variation. And when we add students to that mix, with a further complex of variations (increasing all the time as access to university widens), we get what Ron Barnett has termed "supercomplexity" (Barnett, 2000). Being a student is harder still - all of the same challenges, but with the added uncertainty and lack of experience derived from never having done it before - students are very much, by definition, eternal novices. Caroline Kerber summed up the many dimensions of the challenge of teaching in higher education thus:

> "…a very time-consuming but also scholarly activity in that it requires sound knowledge of one's discipline as well as a good understanding of how to help students grow within, and perhaps even beyond, the discipline. Also, excellent teachers are seen as those who know how to motivate their students, how to convey concepts, and how to help students overcome difficulty in their learning." (Kerber, 2002: p.9)

Excellent teaching is, Kerber argues, a combination of tacit knowledges, evolved through observation of others, much trial and error, reflection and (often ad-hoc) theorisation. If we try to translate that tacit knowledge into formal academic knowledges (as does the Scholarship of Teaching and Learning approach), we would see that the teacher, indeed every teacher, requires a sophisticated understanding of many different fields, including psychology and sociology (alien to many in HE).

The Technological Pedagogical Content (TPACK) model (Koehler and Mishra, 2009) seeks to rationalise this into three domains: content (knowledge of the discipline), pedagogy (knowledge of teaching and learning) and technology (knowledge of the tools through which we implement teaching). This makes it deceptively simple. By decomposing the problem we might be better able to deal with developing effective capability, and from an insitutional perspective, support, for each aspect individually. Decomposition follows on from a scholarly analysis of practice, not the other way around. The pedagogic patterns and practices encoded as pedagogic knowledge (and advice), the curriculum designs and content (text, audio, video), and the technology systems (and support) are engineered to serve teaching and learning, which emerges from what happens, what works best, for real teachers and students in real classrooms. The choices we make for each domain (especially technology) need to be critically informed by a scholarly study of their impacts. But that does not have to be a strictly reactive process. Sometimes we must innovate *actively* so as to disrupt habits.

The designerly imaginations of teachers and students have always been fed by the availability of new ways of learning, especially technologies. Occasionally, such innovations may offer radically new possibilities, extending and transforming our cognitive, social, physical, emotional, political (etc) capabilities. In such cases we cannot easily predict how they will work "in the mix" for all of the many varied teaching activities in a university. In this project we have used an appropriate methodology: "design anthropology" (Gunn *et al.* 2013), creating opportunities for people to experience new technologies, observing what we make of them together, and theorising about their possible wider impact, so as to prime and accelerate the supercomplex process of adopting and adapting.

5. Technical Workshops and Network

Members including:
Amber Thomas
Head of Academic Technologies, ITS Warwick.
Catherine Allen
Independent VR producer and consultant, BBC producer, Warwick Alumnus.
Celine Martin
WMG
Chris Evans
WMG
Dr Clare Rowan
Classics and Ancient History.
Daniel Course
E-Learning Developer, WMG.
Daniel Harrison
Service Owner, ITS.
Darren Stobbs
Network Specialist, IT Services.
David Hopkins
WBS
Devon Allcoat
PhD researcher, Psychology.
Ian Mason
Learning Spaces & Collaborative Environments
Karen Borrows
WBS
Leighton Joskey
Change Lead, Human Resources.
Mark Kirya
WMG
Nicholas Riley
WBS
Philip Tutty
E-learning Technologist, WMG.
Ray Irving
WBS
Rob Batterbee
IT, Careers and Skills.
Dr Robert O'Toole
Senior Academic Technologist ITS.
Ross Mackenzie
Senior Academic Technologist, ITS.
Steve Ranford
Digital Humanities, Warwick.
Tanny Kelley
WBS.
Tim Hollies
Digital Humanities.
Tim White
Theatre Studies.

We began the project with a technical workshop hosted by WMG, led by Catherine Allen. This brought together people with a more technical orientation, to address the first step in our exploration - “VR is well-enough understood amongst HE techies”.

Catherine explained the different types of VR experience, the options for experiencing them, and the tools and techniques required for producing VR. Participants contributed their own knowledge and experiences, and we discussed possible ways in which we could make VR available and supported at Warwick.

The workshop gave us the knowledge necessary to plan further work, leading to us purchasing two 360 VR cameras (a Samsung Gear 360 and a Ricoh Theta). However, it was also clear that VR technology is diverse and developing fast, with no clear single dominating platform or set of protocols.

A table of VR headset systems (June 2017) is included on page 13 of this report.

We went on to explore of of the possible models, creating 360 video tours, following a kind of VR digital storytelling approach.

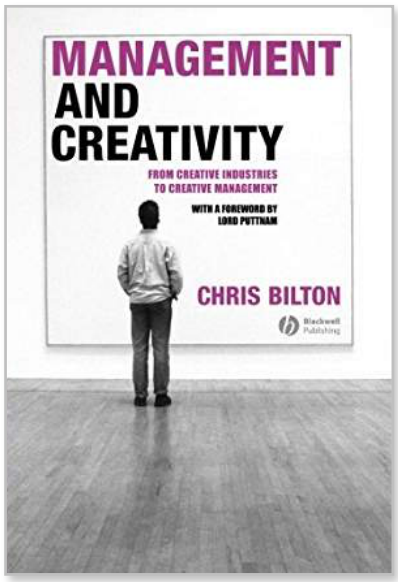
This proved to be more difficult than expected, as the workflows and software for editing are not yet well developed.

We also discovered that there is almost no experitse at Warwick in the Unity programming system required for creating computer generated and interactive VR worlds.

Our later series of VR enhanced seminar workshops explored hi-fi VR systems (Oculus Rift).

6. VR as an emerging creative industry

Pervasive Media Studio, Watershed Arts Centre, Bristol.



During the project I (Robert O'Toole) made several visits to the Pervasive Media Studio in the centre of Bristol (next to the old docks, now converted into an area for cultural and educational activiites). The Studio is a collaboration between the Watershed Arts Centre (in which it is physically based), the University of West of England (a young institution with a strong arts and media base) and the University of Bristol (a world class research university). Founded in 2008, it is at the heart of a network of creative industry businesses and professionals, driving innovation and enterprise in the South West of England. I discovered several Warwick research students and alumni who are based at the Studio, developing new ideas and products, and building careers in new technologies, including VR. It also hosts professors from both academic institutions, embedding research and impact.

Having spent time observing the working practices within the Pervasive Media Studio, I realised that it embodies the characteristics described in the book *Management and Creativity* (2006) by Warwick's Chris Bilton, as well as classic accounts of design innovation practice (Tim Brown's *Change by Design*, 2009; Tom Kelley's *Ten Faces of Innovation*, 2005). The organisation of the Studio facilitates a powerful but loose coalition of people and projects, co-locating in just the right kind of way to encourage mutual support (emotional and practical). This makes creativity possible, not as a sporadic activity, but as a sustained process leading to real products *and* development:

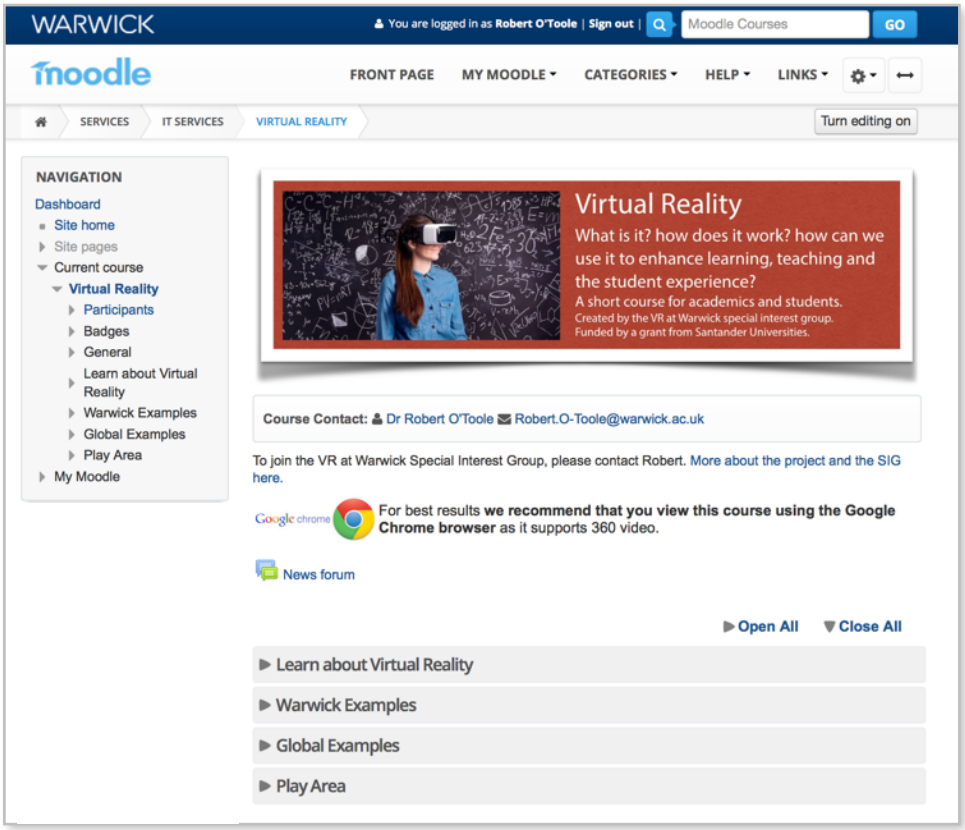
> "Creativity requires diversity and contradiction as the raw material for unexpected lateral connections and `bisociative' leaps of recognition between disconnected frames of reference." (Bilton, 2006: Kindle Location 934).

The studio adapts creativity management approaches from industry, where:

> "Internal cultures in the creative industries are often modelled around aesthetic or social values, or around shared enthusiasm for the company's products. This can result in a fluid, informal style of communication which cuts across hierarchies…" (*ibid.* KL 900)

To the development of a community of intersecting people and projects, with just enough structure and management support (especially when fundraising is required). It is as such, a perfect breeding ground for innovative VR based projects - just the right kind of space and community in which all of the possibilities can be explored, potential winners selected and nurtured, and small scale projects developed into implented products with sustained impact. When we are exploring an unknown and complex new set of technology-practices, like VR, this kind of space facilitates and accelerates innovation.

7. Online Course and How-To Guides



To accompany the project we established a simple online self-study mini course, to act as both a repository for the materials that we developed and as a way in which members of the University can get quality information about VR.

The course was built in Moodle, and will remain once the project is completed. We will continue to add resources and examples over time.

Hopefully we will see the list of examples from Warwick growing.

It was important for us to get people experiencing VR, including the simplest forms possible using only a mobile phone and a £5 Google Cardboard viewer. We bought a set of 10 viewers, and created three "how-to" sheets illustrating how to access good quality free experiences (included at the end of this report):

- Swim with a rhomaleosaurus;
- Walk with Elephants;
- Tour of Monash Science Precinct.

We made these available at a range of events, and found that people were able to use them unsupported.

We also reviewed a selection of other education related VR experiences, compiled into a PDF available in the Global Examples section of the course.

8. VR-enhanced Seminars

Overview

Held over 2 days in May 2017, these workshops provided a diverse group of staff and students at the University of Warwick with a valuable opportunity to experience and think about virtual reality. The VR phenomenon is at the top of its hype cycle (again), with significant breakthroughs having been made in technology and in the design of VR content. However, not many people in higher education have experienced what can be achieved with the latest technologies and content design approaches, and yet fewer have been able to contribute to its development in the context of learning and teaching.

For these workshops we brought an influential VR industry expert to Warwick (Catherine Allen, see the inset at the bottom of this page), along with a range of VR kit (including high-end Oculus Rift headsets). The aim was to observe its use in a real seminar-style situation, to listen to views from a broad range of people (covering arts, science, technology and social science), and to capture their critical and imaginative responses to the seminar. Catherine's experience in designing and running VR activities for arts and entertainment formed the basis of our initial seminar design. We were aware of the importance of six key factors:

- room layout, providing just the right environment for effective and comfortable immersive experiences;
- session design, so as to ensure everyone had enough time, without rushing, and that we could come back together for a discussion at the end;
- choice of VR experiences, aiming to give a good enough range of lo-fi and hi-fi examples;
- reliability of the equipment, so as not to detract with glitches and interruptions;
- clear guidelines and advice for participants;
- refreshments and energy boosters (enough sweets to keep us all going!).

We used 3 Oculus Rift kits including the necessarily powerful PCs, two of which were hired from a conference equipment company (£500 each for three days), and the third borrowed from the Visualisation Lab at WMG. Lo-fi VR was demonstrated using Google Cardboard. A Samsung Gear VR headset was used to demonstrate the mid-level, mid-cost option.

Participants

The 48 participants were carefully selected by the project team so as to achieve as broad a range of disciplines as possible - including academics from Life Sciences, Warwick Manufacturing Group, Law, Chemistry, Philosophy, Education, Theatre Studies, Medicine, Languages and History. We achieved a good male/female balance (22/26), varying ages and physical abilities (including a wheel chair user). Students' Union representatives and current students were included, as well as professionals from the Arts Centre (as there are potential synergies with arts events) and a small number of learning and teaching advisors and learning technologists. A questionnaire was sent to all participants, with some questions to answer before the session, some during and some at the end.

VR experience facilitators & research team

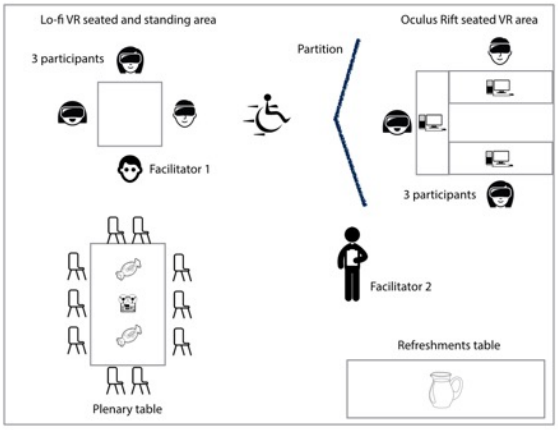
Catherine Allen is a BAFTA-winning, immersive media specialist. She has been responsible for a range of high profile digital entertainment products and has worked with major brands including Disney, Siemens and the BBC. A BAFTA VR associate, Catherine regularly keynotes, judges and mentors at industry events, contributing towards her goal of supporting the healthy growth of an emergent immersive media industry. Catherine is a Warwick Theatre Studies graduate.

Dr Robert O'Toole is a National Teaching Fellow and a Fellow of the Warwick International Higher Education Academy. Robert has a PhD in Arts Education, having researched the potential and reality of design-led approaches to learning, teaching and the student experience in Higher Education. He is a Senior Academic Technologist at Warwick, and graduated in Philosophy.

Format

Each seminar lasted for 1 hour and 15 minutes - a normal session stretched to give us a little extra time to deal with any technical issues that might arise. We had six participants per session. We started with introductions and a briefing, so as to give the participants some idea of what they were to experience and what we hoped to get out of it. Catherine made sure that the comfort and safety of the participants was assured, and we set clear ground rules - including saying that we should not watch other people when they are immersed in the experience, and we should try to be quiet.

The six participants then split into two groups of three. One group moved to the Oculus area for 15 minutes and did the Easter Rising Voice of a Rebel historical VR experience (BBC 2016, produced by Catherine, see inset below for an overview). The other group explored a range of lower-fi VR including Google Cardboard and a Samsung Gear VR. The lo-fi experiences were facilitated by either Catherine or Robert, and guided by a set of 3 how-to sheets. The Oculus group were watched over at all times by the other facilitator, so as to ensure that assistance could be given as required. Following a short break, we came back together as a group for a plenary discussion (audio recorded). Many of these discussions lasted longer than the 30 minutes we had planned for. The room layout was carefully planned to ensure a degree of privacy for the participants, with a partition between the VR areas. Noise from the road next to the building was a problem, windows open on a warm day.



The open area to the right of the lo-fi section proved to be useful, especially for the wheelchair user, who was able to move around safely while in a VR experience. This worked very well.

Initial reflections

Contextualisation matters greatly (as predicted), setting the right atmosphere and environment is key. To begin with, we were too enthusiastic when introducing VR. We decided that we needed to make it seem more normal for the participants. This seemed to help with their ability to get into the Easter Rising VR and to play with the lo-fi VR. More could also be done to set up a space that seems natural (technobiophilic) and less unusual, less experimental and technical, perhaps with some plants and natural lighting.

The high quality immersive experience had a much greater impact than the lo-fi. It is certainly different in kind. May of the participants reported that they were surprised by how they felt within the VR world, with some key points at which they realised that they could move their perspectives and be part of the story. Science, medicine and engineering participants were interested in a greater degree of interactivity than we had on offer (more akin to the HTC Vive), but were still very positive about the Easter Rising.

However, two participants did struggle with the technology, including one with dizziness perhaps caused by being a wearer of bifocal glasses. Some found that the novelty of the tech got in the way of true immersion to begin with. We should give people a chance to redo the experience.

The VR enhanced seminar format works well, and could (with sufficient equipment) be enlarged up to 20 students at a time. However, the equipment is bulky, and for now would need to be installed semi-permanently in a dedicated space. A flipped classroom model may also work well, with students able to book slots at a VR centre to do experiences before coming to a seminar or lecture. There was much interest in creating 360 video for different purposes, including giving viewers a chance to experience different perspectives (e.g. being in a wheelchair on campus).

There was widespread agreement that we should expand the investigation, with the provision of a semi-permanent VR seminar and drop-in space, with dedicated support and tools for making VR experiences.

Easter Rising - Voice of a Rebel

Created by the BBC and VRTOV, Easter Rising takes us back through time to explore the memories of one man who was a rebel in the siege of the Dublin GPO in 1916. The sudden acceleration in VR technology is complemented by a new generation of VR content, exploring many varied formats and genres. Easter Rising as an example of serious VR, with direct relevance to some academic disciplines. Our objective was to show how well-designed, hi-quality VR, experienced in the right setting, can deliver an experience that is bodily, emotionally and intellectually immersive and challenging.

9. Findings

VR replaces the lecture? An unlikely scenario.

There are many ways in which VR will usefully augment and extend teaching across all of our academic disciplines. Some of these uses will tend towards the immersive "story-doing" kind of experience (in the style of Easter Rising). Others will be more interactive, using haptic interfaces (for example, the bio-molecular systems being developed in Life Sciences).

People are now getting limited access to simple VR experiences (360 video on Google cardboard). Games-based VR is also taking-off fast amongst dedicated games players. However, we found very few people who have had a significant, meaningful, satisfying VR experience. This, in combination with media hype, has resulted in **distorted expectations and understandings becoming commonplace**.

VR technology is not like other familiar digtal technologies (television, laptops, tablets, smart phones etc). It relates to the body, the brain, experience and identity in a much more radical way. **Adoption of VR technologies is more challenging**, and will take longer and require more experimentation and reflection. We may find that people do not use VR in everyday places - for example at home or at public events. VR is valuable, but needs to occur in the right setting.

VR needs a physical home at Warwick, a space designed and supported specifically for good quality VR experiences. This is equivalent to the need for dedicated theatre spaces - a specialised space, not a generic space. When experienced in poorly designed spaces, VR can be worse than disatisfactory, it can be emotionally and psychologically damaging.

The provision of such a space would accelerate adoption and ensure that we get the most out of the new technologies, with them becoming an ordinary, well understood and widely valued component in learning, teaching, research and the student experience.

The space needs to be designed and facilitated in a way that makes it easy for people to experience a broad range of VR, including quite challenging productions, in a safe, comfortable, reflective setting.

A more likely scenario.

Specialised, selective VR, augmenting existing teaching.

It needs to be accompanied by technologies and support for creating VR. Production of VR is unlikely to become an easy everyday activity. A combination of technical, creative, design and management skills is required. **Many of these skills (especially Unity VR programming) are scarce at Warwick.** To make it happen we need a focal place for a network of people (staff and students) with the required skills and innovative ideas. We need to organise training opportunities to increase the number of people with key skills (especially Unity).

This would be **best accomplished as part of a wider programme to develop higher quality specialised spaces and facilities for the "student as producer" of innovations (a maker space approach).**

There is a link between the VR space and other innovative spaces, including the proposed Nest (student project building) and spaces dedicated to "restorative and meditative" practices.

10. Recommendations

Oculus Building at the University of Warwick, architects Berman Guedes Stretton.

Oculus Building lecture theatre.

Jock Marshall Reserve Integrated Learning Facility, Monash University, architects Harmer (Australia).

Warwick does not have suitable spaces for VR experiences or for VR production (a maker space). It urgently needs such spaces, around which a network of expertise and ideas may develop.

There is as yet very little understanding of VR and its potential at Warwick University, outside of niche areas (within WMG, Classics). As we discovered through this project, adopting VR is not simple. We do not think that it can be compared to buying a different kind of computer or television. VR is an entirely new kind of medium, and yet more than a medium - a different way of being with our bodies and the digital, and most likely, a very different kind of learning experience.

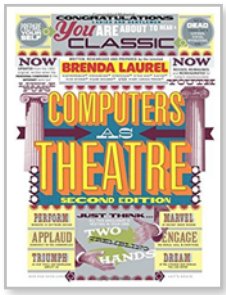
We can see that VR can usefully augment conventional learning environments and activities, especially the seminar. However, it requires a different kind of physical space and a different kind of relationship between participants (including teachers) following its own protocols.

Such a space needs to be especially well designed - as high quality as our new teaching spaces (coincidentally called the Oculus Building), with an emphasis on comfort, good natural light, noise reduction and relaxation. Such spaces should use nature, include plants and water. Designed for what has been called “technobiophilia” - making the technological aligned with nature, our minds and our bodies. For VR to flourish we recommend that the University integrates VR facilities into spaces that are designed to bring together technology and the natural environment.

The Integrated Learning Facility at the Jack Marshall Reserve, Monash, Australia, is a good example of a technobiophilic learning space. The proposed Nest student innovation building at Warwick is perhaps the most suitable planned location at Warwick, and would be a good base for a VR lab - being both a technology enhanced seminar space and a maker space in which VR production could happen within a peer-supported network.

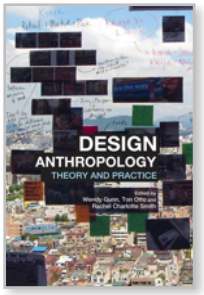
11. Further Reading and Resources

4 key books used in this project

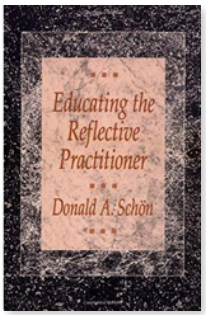


Computers as Theatre, Brenda Laurell, 1993/2013. Pioneering reframing of technology design, including VR, with an emphasis on user *participation* in designed and emergent experiences. Key text for studying VR.

Technobiophilia, Sue Thomas, 2013. A call to reconsider the technology/nature dichotomy, Tech experiences can and should be aligned closely with the natural world. This is especially important for VR.



Design Anthropology, Wendy Gunn *et al.* 2013. An exploration of the "design anthropology" method for researching and co-designing with diverse participants. This forms the methodology for this project.



Educating the Reflective Practitioner, Donald Schön, 1990. Key text for understanding workshop or studio based learning. How might VR contribute by expanding the scope for prompting and guiding reflection?

Articles on VR by Catherine Allen

VR 101 for publishers: The logistics of showing VR to first timers
http://tinyurl.com/y9jc9482

VR for publishers 101: Why diverse teams will help you make better virtual experiences
http://tinyurl.com/y7v8cmpm

VR for publishers 101: How to distribute your virtual reality story
http://tinyurl.com/y6unckco

VR for publishers 101: What works well in virtual reality?
http://tinyurl.com/yak9r5g8

With VR, publishers must focus on storydoing, not storytelling
http://tinyurl.com/yaeqzl5y

5 key considerations for ethical virtual reality storytelling
http://tinyurl.com/y9mpo7go

Blogs and Twitter

http://360rumors.com - latest news on cameras and editing software.
http://www.digitalbodies.net - VR, AR, wearables and education.
@VirtualSarahJ - VR expert at Coventry University.
@VRforEd - VR in education.
@VRPlayhouse - VR creative studio.
@_VRTOV_ - VR company in Melbourne, Australia.

Research on innovation methods by Robert O'Toole

Fit, Stick, Spread and Grow: Transdisciplinary Studies of Design Thinking for the [Re]making of Higher Education
http://www.inspireslearning.com/thesis

Virtual Reality and Augmented Reality technologies - June 2017

New VR and AR technologies are emerging fast. This table gives an overview of the current main alternatives, with an indication of the kinds of educational applications they are targeted towards. Note the range of costs, from £5 (plus a phone) up to £4500. Even the cheapest of options may be of significant value if used appropriately.

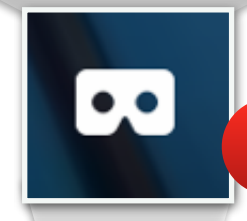
	Estimated minimum cost of entry (June 2017)	Immersivity	Interactivity	Educational applications
Google Cardboard	**£5** for the basic viewer, **requires a phone** with a screen larger than 6 inches. Good quality headphones improve the experience. Most experiences are free to download.	**Variable**. Of the many variants available, made of cardboard or plastic, some fit some people well. High quality noise cancelling headphones can add to the sense of immersion. Low screen resolutions result in discomfort and dissatisfaction. Most viewers do not work well for people wearing spectacles.	**Low**. Cardboard uses an ingenious system. Most headsets include a button, often on the top right. This activates a lever which simulated a finger touching the screen of the phone. Some experiences include the ability to look at menus and hotspots, a cursor appears and clicking the button activates the hotspot. This is often used to change the point of view.	Mostly used for viewing 360 videos. There are many available for free (see YouTube). They can be used to give students experiences that they would not otherwise have access to. The addition of a 360 camera, and editing facilities (e.g. Adobe Premiere) expands the educational potential. The Sketchfab VR app contains many minimally interactive 3d objects that can be viewed in Cardboard. Google Expeditions allows for multi-person VR expeditions in which participants follow a leader on virtual field trips.
Google Daydream	**£80** for the viewer, but requires an expensive **Google Pixel phone (£700+).**	**Medium.** Beautifully designed head set, light, soft, cool and comfortable. Fits most people well. Combine with noise cancelling headphones for best results.	**Low**. A small hand held controller acts as a kind of laser-pointer/mouse, controlling a cursor in the view, and activating hotspots and menus.	Similar to Google Cardboard, but with some Daydream specific apps giving more interactivity.
Samsung Gear VR	**£50** for the viewer, **£120** with motion controllers, but requires a recent **Samsung phone**. Some free experiences, some at cost.	**Medium.** If fitted well, with straps carefully adjusted, and high quality headphones, provides a good experience, especially when binaural (3d) audio is included in the experience.	**Low**. The headset has a difficult to use controller on the side. Recent versions come with a handheld controller. Also includes the option to use for augmented reality (AR) with virtual objects superimposed over a view of the real world captured via a built in camera.	360 video and many interactive apps - increasingly experiences designed for Oculus Rift are also available for Gear VR. Many of these apps allow the participant to explore and take action in places that would otherwise be inaccessible - e.g. anatomy. The addition of a Gear 360 camera (£300) makes creating VR experiences easy.
Sony Playstation VR	**£350** for the viewer plus **£300** for the Sony Playstation, **£45** for Playstation headphones, Playstation Camera (required) **£40**.	**Medium**. Lightweight and comfortable, with good resolution and sound (with headphones). 1920x1080 full-HD OLED, 120 Hz refresh. Fast response to movement, said to be indistinguishable from real life.	**Medium**. This is a games-oriented VR system, so designed for seated VR interactivity from the outset. Optional Playstation Move controllers cost an additional £40. Includes head position tracking using the Playstation Camera.	Not yet evaluated. Likely to be more games oriented.
HTC Vive	**£800** for the viewer, controllers and sensors, but also requires a **powerful PC (£1000+).** Some next generation Macs will also work. Some free experiences, some at cost.	**Medium to high**. The head set is high resolution (2160x1200, 90 Hz), with a good refresh rate. However it does not include integrated audio. A "Deluxe Audio Strap" is available for an additional £235.	**High**. Room-scale VR, in which the participant is tracked moving around. Currently limited by wired connection to the PC, but in near future will be wireless. Comes with two handheld controllers, which allow for quite precise manipulation of virtual objects.	The Vive's precise controllers are the best choice for interactive simulations, such as laboratory simulations. Room scale VR will allow for much more elaborate simulations.
Oculus Rift	**£600** for the viewer and controllers, but also requires a **powerful PC (£1200+)**. No Mac compatibility. Some free experiences, some at cost.	**Extremely immersive**. High resolution and refresh rate. When fitted correctly, the visual field is completely enclosed. The built in headphones are excellent and capable of 3d audio, easily mimicking reality.	**Medium**. Seated VR, but with high precision tracking of head position. This means that the participant can lean in all directions to adjust point of view. Oculus Touch controllers can be used (one in each hand) to manipulate virtual objects. Also includes an Xbox One controller for VR games.	Especially good for short (10 minute) deeply immersive experiences that make the most of the Rift's high quality 3d binaural sound. Can have a dramatic emotional impact on participants.
Microsoft HoloLens	**£2700-£4500**, no additional computer required.	**Low**. Augmented Reality, the opposite of immersive experience. Graphics are overplayed through a head up display as 3d objects in the normal field of view. However, the area of view that may be used for graphics is quite narrow.	**High**. Turns the real world into a 3d computer interface, superimposing hotspots, menus, manipulable virtual objects onto the participant's view of the real world.	New and not yet well developed, but many possibilities, such as the ability to provide novice practitioners with immediate access to context sensitive information, or advice from other users, when working in complex environments.

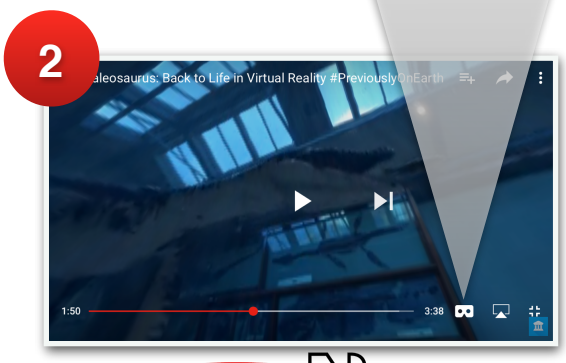
Swim with a rhomaleosaurus in virtual reality

Mobile Phone + YouTube app + Google Cardboard

Many amazing experiences are available using just an ordinary smart phone. The Natural History Museum, for example, have created this brilliant immersive movie in which an ancient marine reptile comes back to life. Play it on the YouTube app, with the phone placed into a Google Cardboard viewer (£5-£10), and move your head around to follow the vast but graceful beast as it swims by. What other ancient sea creatures can you spot swimming in its wake?

1. Load the phone into a Google Cardboard viewer.
2. Search for **Rhomaleosaurus: Back to Life in Virtual Reality** in the YouTube app.
3. Activate 360 viewer mode.
4. Follow the plesiosaur through the hall at the Natural History Museum, move your head left, right, up and down to explore.





YouTube NATURAL HISTORY MUSEUM

The movement sensors in your phone interact with the app to control your point of view in the experience. If you don't like the viewer, you can still follow the plesiosaur without activating the 360 mode. Move your phone around to change your viewpoint. You can also do this using YouTube 360 videos in the Google Chrome browser on your computer. This movie is a great example of a photo realistic animation, combining 3D images of a real location with computer generated imagery. Search for Natural History Museum in YouTube to find more examples.

Learn more about VR at: warwick.ac.uk/kickstart-vr

Dr Robert O'Toole, March 2017

Tour the Monash Science Precinct in 360º

Mobile Phone + YouTube app + Google Cardboard

Monash University is justifiably proud of its campus and its science facilities. In this VR experience we get a guided tour, including traditional laboratories, an outdoors environmental lab, and some nice learning spaces. Play it on the YouTube app, with the phone placed into a Google Cardboard viewer (£5-£10). This is a slick and professionally produced video, with voice over. The imagery is so good, you might find yourself unwittingly wanting to step into the picture and walk about.

1

3

2

4

1. Install the YouTube app (if you haven't got it already).Search for Monash Science Precinct and access the video.
2. Activate 360 viewer mode using the button at the bottom left of the screen.
3. Quickly place the phone into the Google Cardboard viewer. You might also want to use headphones, as this will improve the sound quality.
4. Notice how floating images have been added to the video recording. This can be achieved in Adobe Premiere. We can also added text to the video.

This VR experience illustrates how 360º is being used as a promotional tool. Does it do enough to give a sense of what the place is really like? Or is the focus limited to just giving a glossy flavour? The use of voice over in this way aligns it more with promotional uses. However, similar techniques might also be used to give a deeper cultural exchange, perhaps with interviews with real people or short clips in which we get to see people in locations in action, interacting with each other.

Learn more about VR at: warwick.ac.uk/kickstart-vr

Dr Robert O'Toole, March 2017

Walk with elephants in 360º VR

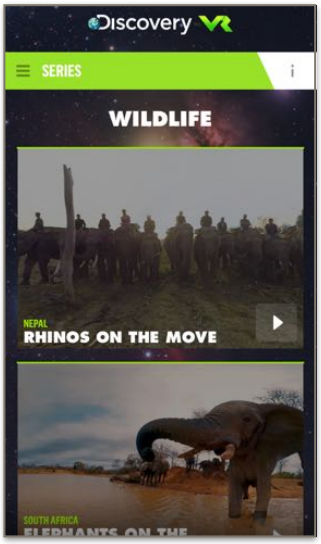
Mobile phone + Discovery VR app + Google Cardboard

Traditional television companies are experimenting with Virtual Reality. Discovery Channel have created their own app through which their VR experiences are brought to your mobile phone. The wildlife experiences are especially impressive. In this example we get very close up to a herd of wild African elephants. Experience the sights and sounds of the bush. See elephant behaviour in 360º immersive reality. This works well when you fit your phone into a Google Cardboard viewer (£5-£10), with headphones plugged into your phone.

1

2

3



1. Install the Discover VR app on your phone.
2. When the app starts, use the Series menu to find Wildlife.
3. Find and start Elephants on the Brink (or whatever takes your interest).
4. Activate 360 viewer mode.
5. Quickly place the phone into the Google Cardboard viewer.
6. Enjoy elephants in 360. Move your head around to change your point of view. For extra realism, where headphones to hear the sounds of the herd.

4

5

6

The 360º footage for this movie was filmed using a set of small cameras placed in a rig - for example it might have used 6 Go Pro action cameras, each pointing in a separate direction. This is a relatively expensive set up. Smaller cheaper single camera set ups are becoming available that can achieve the same results.

Try out the other VR experiences in the Discovery VR app. Consider which topics work best in 360º

Learn more about VR at: warwick.ac.uk/kickstart-vr

Dr Robert O'Toole, March 2017