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Virtual worlds in Australian and New Zealand higher education: Remembering the past, understanding the present and imagining the future

Sue Gregory
School of Education
University of New England

Brent Gregory
UNE Business School
University of New England

Torsten Reiners
Curtin Business School
Curtin University

Ali Fardinpour
Curtin Business School
Curtin University

Mathew Hillier
Teaching & Educational Development Institute
The University of Queensland

Mark J.W. Lee
School of Education
Charles Sturt University

Lisa Jacka
School of Education
Southern Cross University

Des Butler
Faculty of Law
Queensland University of Technology

David Holloway
School of Information Systems & Technology
University of Wollongong

Scott Grant
School of Cultures, Languages & Linguistics
Monash University

Merle Hearns
School of Foundation Studies
Manukau Institute of Technology

Kim Flintoff
Curtin Teaching & Learning
Curtin University

Jay Jay Jegathesan
School of Physics
The University of Western Australia

David Ellis
School of Education
Southern Cross University

Marcus McDonald
School of Health Sciences
RMIT University

Frederick Stokes-Thompson
Learning & Teaching Unit
University of South Australia

Belma Gaukrodger
Flexible Learning
Nelson Marlborough Institute of Technology

Jason Zagami
School of Education & Professional Studies
Griffith University

Chris Campbell
School of Education
The University of Queensland

Xiangyu Wang
School of Built Environment
Curtin University

Jamie Garcia Salinas
School of Social & Behavioural Sciences
The University of Queensland

Swee-Kin Loke
Higher Education Development Centre
University of Otago

Sheila Scutter
School of Medicine & Dentistry
James Cook University

Christine Newman
eLearning Services
Queensland University of Technology

Ning Gu
School of Architecture & Built Environment
University of Newcastle

Stefan Schutt
Centre for Cultural Diversity & Wellbeing
Victoria University

Helen Farley
Australian Digital Futures Institute
University of Southern Queensland

Anton Bogdanovych
Computing & ICT
University of Western Sydney

Tomas Trescak
Deans Unit School of Computing, Engineering & Math
University of Western Sydney

Simeon Simoff
School of Computing, Engineering & Math
University of Western Sydney

Caroline Steel
School of Languages & Comparative Cultural Studies
The University of Queensland

Penny Neuendorf
Flexible Education
Canberra Institute of Technology

Matt Bower
Department of Education
Macquarie University

Lindy McKeown Orwin
Australian Digital Futures Institute
University of Southern Queensland

Tom Kerr
Faculty of Business & Economics
Macquarie University

Ian Warren
School of Humanities & Social Sciences
Deakin University

Denise Wood
School of Communication, International Studies & Languages
University of South Australia

Charlynn Miller
School of Science, IT & Engineering
University of Ballarat

Shane Mathews
QUT Business School
Queensland University of Technology

Dale Linegar
Oztron

Vicki Knox
School of Behavioural, Cognitive & Social Sciences
University of New England

Yvonne Masters
School of Education
University of New England

Ross Brown
School of Information Systems
Queensland University of Technology

Grant Meredith
School of Science, IT & Engineering
University of Ballarat

Clare Atkins
School of Business & Computer Technology
Nelson Marlborough Institute of Technology

Angela Giovanangeli
Faculty of Arts & Social Sciences
University of Technology, Sydney

Karen Le Rossignol
School of Communication & Creative Arts
Deakin University

Andrew Cram
Navitas Professional

Eimear Muir-Cochrane
School of Nursing & Midwifery
Flinders University

Arin Basu
School of Health Sciences
University of Canterbury

Michael Jacobson
CoCo Research Centre
The University of Sydney

Ian Larson
Monash Institute of Pharmaceutical Sciences
Monash University

3D virtual reality, including the current generation of multi-user virtual worlds, has had a long history of use in education and training, and it experienced a surge of renewed interest with the advent of Second Life in 2003. What followed shortly after were several years marked by considerable hype around the use of virtual worlds for teaching, learning and research in higher education. For the moment, uptake of the technology seems to have plateaued, with academics either maintaining the status quo and continuing to use virtual worlds as they have previously done or choosing to opt out altogether. This paper presents a brief review of the use of virtual worlds in the Australian and New Zealand higher education sector in the past and reports on its use in the sector at the present time, based on input from members of the Australian and New Zealand Virtual Worlds Working Group. It then adopts a forward-looking perspective amid the current climate of uncertainty, musing on future directions and offering suggestions for potential new applications in light of recent technological developments and innovations in the area.

Keywords: virtual worlds, 3D multi-user virtual environments, simulation, gamification, augmented reality, natural interfaces

Introduction and background

Higher education institutions across Australia and New Zealand have been utilising the affordances of 3D virtual worlds (VW) for research, teaching and learning for a number of years, some since as early as 1979 (Gregory et al., 2012). The Australian and New Zealand Virtual Worlds Working Group (VWWG), to which the authors of this paper belong, was established in 2009 and consists of almost 200 educators, educational designers/developers and researchers with a diverse interest in VWs. Almost all of the universities in the two countries, a number of Australian TAFE institutions and private higher education providers as well as several New Zealand polytechnics and institutes of technology are represented in the membership of the VWWG.

A variety of VW platforms have been used across the institutions but the majority have been using Second Life (SL), OpenSim and, more recently, Unity3D, Jibe and Minecraft. The background of some of the institutions will be discussed in relation to their use of VWs for learning and teaching, placing the reader in context. Firstly, a short literature review provides an overview of the use of VWs in higher education institutions. The following section discusses how VWs have been used in the past at authors' institutions. The next section provides an understanding of the present and finally imagining the future with some concluding remarks in relation to VWs, past, present and future. Thirty-two members of the VWWG from 18 Australian and New Zealand institutions responded to a survey requesting information about the trends affecting VWs at their institution. Thirty-four members responded to a request on how they were using VWs in the past, present and future. Their responses are outlined in this paper. Overall, 52 authors have contributed to the discussion in this paper.

Literature Review

In the early 1980s virtual reality emerged as an innovative technology that changed the way we interact with a computer. Immersion in an environment was assisted by the ability to move and view in three dimensions (3D) within the environment and by the use of synchronous communication with other users. The increase in access to both higher capacity computer hardware (storage, graphics and memory) and higher speed connectivity to the Internet has facilitated the ability to connect to work, study and entertainment anywhere, anytime, using 3D multi-user virtual environments. In our discussion, we define a VW as a computer-based, immersive, 3D multi-user environment that simulates real (or imaginary) life, experienced through a graphical representation of the user.

A great deal of literature has emerged in the past 20 years in relation to the potential strengths and learning benefits associated with the pedagogical use of VWs (see, for example, Dalgarno & Lee, 2010; Hew & Cheung, 2010; Mikropoulos & Natsis, 2011; Wang & Burton, 2012). Many educators have seen the potential for VWs and have pursued their use in higher education. For the past three years the VWWG has documented the use of VWs in higher education in Australia and New Zealand (Gregory et al., 2010, 2011b, 2012; Hearns, 2011). In this paper we continue to describe what universities are doing and also consider where they are going. A strong message from the literature is the need for sound learning design and pedagogy that fully utilises the potential of the VW (Dalgarno & Lee, 2010; Mikropoulos & Natsis, 2011; Salmon, 2009; Savin-Baden et al., 2010). There is also some way to go in the areas of IT management and logistics of VWs, not to mention user literacy (Dudeney & Ramsay, 2009; McDonald, Ryan et al., 2012). Despite the existence of VWs over a significant period of time we are perhaps still in an exploratory phase as we are mapping out best practice often without institutional support, resulting in an approach that is less than systematic. Salmon (2009, p. 526) suggests, "we need much stronger visions to help us get ready to point the way to evidence based research, rather than merely 'reacting'." Collins (2008, p. 60) also advocates an imaginative approach to reframing the way we think and talk about VWs, that they are more of "an exciting new laboratory" or "a giant sandbox" rather than a "technology application". VWs are a way to step into our collective imaginations in a manner that we have never been able to do before. In this paper, the authors combine their analysis of emerging trends and developments with their imaginations to collectively envision the future for VWs in education.

Remembering the past

In this paper twenty-nine institutions from the VWWG come together to discuss the context of teaching, learning and research in a VW from either their personal and/or institution's point of view. When exploring joint papers presented by VWWG at ascilite over the past three years (see Gregory et al., 2010, 2011, 2012), it can be seen there has been much hype around the use of VWs for teaching, learning and research. However, this initial exuberance has subsided and been replaced with a more pragmatic approach to their use. At this point it appears that higher education institutions are either opting out of using VWs, or are continuing on a "business as usual" path with very few opting for large new initiatives. Those that continue to utilise VWs do so either having already decided to centrally support an institutional VW presence, some at reduced levels or are continuing to use VWs in a limited capacity, typically relying on the efforts of individuals or small teaching teams. In a number of cases the reliance on a few key individual champions has meant that when those individuals move on, the use of VWs diminishes considerably or ceases in their institution; too often this occurs without a digital preservation strategy in place resulting in resources being lost to the community.

Understanding the present

VWs provide a highly flexible and engaging facility for students and staff to build scenarios and simulations, virtual meeting places and a platform to investigate how online virtual environments can meet teaching and learning needs into the future. The diverse and active communities in VWs and the incredible range of resources available keep many institutions active in their research, teaching and learning in VWs. There remains much enthusiasm on the use of VWs amongst the VW educational community but issues such as bandwidth availability for students, institutional infrastructure and support blockages, the reliance on specialist skills needed to use VW educational development tools, the sharing of innovations and awareness of the capabilities of VWs in the general academic population are still barriers at many institutions that need to be overcome before wider adoption can be achieved.

Many academics continue to teach because of the pedagogical advantages afforded by these environments (both for on-campus and off-campus learners) and because of the learning opportunities that might not exist or be possible in other environments. They also recognise new learning opportunities that arise as the technology behind the VW environments improves and the technology that gives users access to the environment improves (e.g. NBN, tablets, smartphones, etc.). They continue to research because learning in these environments (as in many environments) provides opportunities for research; some of these opportunities are unique to the environments; these environments facilitate the collection of data in ways that might not be available in other environments; and, comparisons of the same learning related phenomenon can be made between VW environments and other environments which may highlight aspects that would not necessarily be obvious without such comparison.

Table 1 outlines the way in which VWs are currently being used at each of the 19 institutions surveyed for this paper. The table details how the technology is supported (whether on an ad-hoc basis through the efforts of individual academics or teaching teams, often funded by grants, or through centralised institutional funding and support), the VW used, the disciplines that are using VWs and the nature of the use at each institution. SL is still the most common VW in use (15 of the 19 institutions), however it remains the sole VW at only 5 institutions. Alternatives are on the rise with approximately half (10) of the institutions using OpenSim (an open source equivalent of SL that can be installed on an institutions' server, individual PCs or on USB devices) and eight institutions are using Unity3D. Other VWs used include Sim-on-a-Stick (SoaS – a VW wholly contained and usable on a USB thumb drive), Jibe or Kitely being used at one institution each with two trialling Minecraft. There is much experimentation being undertaken to find the "right" VW for the various institutions' requirements. Custom developed VW systems are in a tiny minority with the majority still looking to readily available platforms.

Institutions are using VWs for a variety of research, learning and teaching activities. The 19 surveyed institutions reported activities being undertaken that include: role play activities (9); machinima (video captured from within a VW) (4), virtual tours (5); PhD students (2); staff or faculty development (2); careers services (2); institutional marketing (2); and, although not reported in the table, all institutions are using VWs for research, collaboration and communication. Individuals also reported that VWs are being used for scenarios that aim to develop a range of employability or "soft" skills. Table 1 summarises these findings.

Table 1: Summary of institutional use of virtual worlds

Institution and *Support Basis (Central support or ad-hoc use)*	**3D virtual world used**	**Disciplines**	**Nature of use**
Curtin University *Ad-hoc*	SL, OpenSim, Unity3D, Minecraft, Augmented Reality	Business, Physics, Building, Health Sciences, Logistics and Supply Chain	Trials, simulations, student activities, projects, retention.
Griffith University *Ad-hoc*	Unity3D, Minecraft, SL, OpenSim, Cloud Party	Education	Simulations, machinima, tours, demonstrations and student projects/builds.
James Cook University *Ad-hoc*	OpenSim, Unity3D	Health	Demonstrations
Manukau Institute of Technology *Central support*	SL, OpenSim	Foundation Studies, Language Literacy and Numeracy, Language Culture and History	Interactive demonstrations, tours, group activity, guest speakers, student activities, game based activities, simulation and role play.
Monash University *Local support/Ad-hoc*	SL, Unity3D	Languages, Pharmacy, Orientation, Outreach	Student activities, role play, low-level AI, virtual tableting facility, process simulation, campus orientation and exhibitions.
Nelson Marlborough Institute of Technology *Central support*	SL, OpenSim, Kitely	Languages	Student activities, group work, collaboration and projects.
Queensland University of Technology *Central support*	SL	Law, Education, Marketing	Machinima for demonstrations and scenario, tours and marketing.
RMIT University *Ad-hoc*	SL	Health Science, Medicine	Role-play and group activities.
Southern Cross University *Central support/Ad-hoc*	SL, OpenSim, SoaS	Nursing, Business, Education, Building	Student created resources for teaching. Design analysis and critical evaluation.
University of Ballarat *Central support*	SL	Science, Information Technology, Nursing, Engineering, Marketing	Demonstrations, marketing, support environments, role play, collaboration and cooperation.

University of New England *Ad-hoc*	SL	Education, Pharmacy, Accounting	Show, practice examples, role play, guest lectures, virtual tours, PhD, research, machinima and meetings.
University of Otago *Central support*	OpenSim	Medical Education	Role play (clinical decision-making and peer assessment).
The University of Queensland *Central support/Ad-hoc*	SL, OpenSim, Unity3D, Custom-platform	Faculty Development, Education, Pharmacy, Statistics, Health	Faculty development, PhD research space, virtual compounding dispensary and student activities.
University of South Australia *Central support*	OpenSim, SL	Careers	Services, resource delivery, virtual site visits, scenarios, role play, soft skill development and careers.
University of Southern Queensland *Ad-hoc*	SL, Jibe	Careers	Virtual career fair, machinima and demonstrations.
The University of Western Australia *Local Support/Ad-hoc*	SL	Art and Film, Anatomy, Physiology, Human Biology, Education, Outreach	Demonstrations, student activity, simulations, public exhibitions, competitions, education outreach, demonstrations and machinima.
University of Wollongong *Local Support/Ad-hoc*	Unity3D	Nursing	Role play and scenarios.
Victoria University *Ad-hoc*	Unity3D	TAFE Construction, Biotechnology, Engineering	Role play, simulation, tours and embedded energy efficiency calculators.
University of Western Sydney *Central Support*	SL, OpenSim, Unity3D, iClone, Augmented Reality	Computing and ICT, Industrial Design, Digital Humanities, e-Health and Health Sciences, Linguistics	Immersive simulation environments for research and teaching, student created resources, augmented reality and robot integration.

Offline, standalone VWs such as SoaS are not affected by bandwidth, with use at a number of primary schools showing the ability to offer least some of the same pedagogical goals as online VWs. The current trend towards browser-based access to VWs makes it easier for staff and students to access VWs directly, which bring role play and machinima for distance education students into reach. Machinima is being used to contextualise otherwise abstract concepts and principles. Intranet versions of VW servers make the development of internal secure grids possible. Mobile VW clients, to facilitate ad hoc, ubiquitous usages of VWs in educational scenarios are another area that is seeing an increase in use.

VWs are being used to cater for large numbers of students seeking an education while struggling with work and family constraints. The utilisation of VWs enables groups of students removed from the campus to work in collaboration on projects that enhance their learning experiences. They enable lecturers to provide activities that would be impossible in the real world with the current economic constraints imposed on tertiary institutions.

Research in VWs is being encouraged at some institutions, particularly in areas that will lead to improved retention and success of students. Universities need to create a supportive environment for the development of a wide range of virtual learning environments in terms of policy, the academic environment, practical support (particularly in relation to computing) and networking infrastructure and preservation.

VWs, 3D virtual environments and simulations have now been embedded in a number of institutions. While not widely used across all disciplinary areas, it is likely that their use will continue to grow and develop over time, although their growth is more likely to be driven by individuals rather than the collective institution. On the other hand, the novelty of using VWs for learning and teaching has worn off for some, as has the momentum, particularly given advances in cloud computing and the use of tablet technologies which increasingly promise to streamline core curriculum delivery.

Could it be that we are at a cross roads, perhaps at the point at which WV technology stops being an "emerging" technology and moves to more mature level? While the initial exuberance and hype surrounding VWs like SL has passed, the underlying platforms on which it is built, along with 3D engines like Unity3D are now relatively stable and mature technologies that allow a range of VW environments to be built and used. However, the future is anything but set and we will continue to see research into the use of VW platforms as educators search for the right platform to meet their specific needs and seek to incorporate the emerging technologies of the future.

Imagining the future

The authors, all experts in the use of VWs for research, teaching and learning, take on the challenge of imagining how VWs will be used in the future. The following section features some of the ideas that emerged as a result of a Delphi like process used by the authors. This first involved an online survey of the group which was then followed up with iterative editing cycles to arrive at the headings below.

Increase in the fidelity and realism of virtual worlds

VWs will continue to improve in quality, leading to even greater levels of visual, auditory and other sensory immersion, opening the door to greater opportunities for authentic learning.

Increase in fidelity and quality
Over time, VWs will improve in terms of the fidelity with which they are able to simulate aspects of the real world and the quality of the user experience that they are able to deliver. While VW platforms increase in their efficiency to display more detail with less data, the bandwidth demands are likely continue as more is expected. Bandwidth and technological issues may no longer be an obstacle to accessing VWs for many in Australia if the NBN lives up to its promise while others may be increasingly left behind. Software platforms, available Internet bandwidth and end-user hardware will provide even greater levels of immersive fidelity, flexibility of design (environment, pedagogy, tasks) and use, and acceptance by learners. VWs will have caught up to the look and feel and overall quality of more advanced video games and therefore better accepted by all stakeholders as a pedagogical alternative. They will increasingly come closer to the (positive) image of the virtual environment outlined in the book, Snow Crash (Stephenson, 1992). As a result there will be much more interactivity between stakeholder avatars and greater opportunity for creativity. There will be a single avatar, with one inventory for just one life that goes across all platforms. There will be a consolidation in the number of VW platforms.

Voice/text
Voice and text communications will be improved to appear in line with face-to-face communication. Lip-syncing will be enhanced and facial expressions replicated. VW technology has already moved some way towards being able to achieve this at present with reasonably accurate lip-syncing being available.

Blurring of boundaries between the real and the virtual

The increase in the fidelity of virtual VWs themselves will also need to be matched by increases in the ability for people to interact with them in more realistic ways. Currently, most VWs do not keep up with the variety of input and display technology that is available. VWs are intended to be immersive but many still rely on keyboard, mouse and 2D monitors placed on desktops as their interface. Future VWs will need to break down these barriers in order to enable a truly interactive, immersive and mobile experience by taking advantage of the full range of devices and approaches that are available. The availability of VWs through a multiplicity of interaction devices and mobile computing platforms will blur the boundary between the VW and the real world. Metaverse roadmap suggests we think of the future of VWs "not as virtual space but as the junction or nexus of our physical and virtual worlds" (Smart, Cascio & Paffendorfs, 2007, p. 4).

Mobility
Mobility will increase in terms of options for user access. Mobile technologies featured prominently in the recent NMC reports for Australia and New Zealand and are consistently listed as being on the immediate, short-term (one year or less) horizon (Johnson et al., 2010, 2011, 2012, 2013). VWs increasingly work across platforms including mobile devices such as tablets and phones with increasing ease as the capabilities of the mobile devices improve and the capacity of mobile networks to which these devices are connected increase. Quick Response (QR) codes are already being used to facilitate easy access to particular locations and objects within a VW using mobile devices. These are two-dimensional barcodes that can be photographed using the camera of a mobile phone or similar device as an alternative to typing a URL. New devices such as Google Glass will facilitate even greater mobile access and given the augmented reality style interface that is within the regular field of vision of the user, this will lead to VW access being available at anytime, in any place. Such a confluence of technologies should mean that for those with access to the devices and networks, access/usability issues would be greatly reduced over time.

Rich and intelligent blended learning
The fusion of virtual worlds and artificial intelligence will continue to provide authentic augmented environments tailored for specific pedagogical strategies. The resulting technology supports the integration of contemporary e-research and blended learning, for example in the area of digital humanities (Bogdanovych et al., 2012). Specialised artificial intelligence techniques will provide the authenticity of the look and behaviour of

the populations in these environments. For instance, virtual cities can be populated with diverse crowds of virtual agents that genetically preserve their ethnic features through the generations (Trescak et al., 2012).

Augmented reality

Augmented reality (AR) technology has been in existence for many years, but is only beginning to enter the mainstream in higher education. It was identified by the 2010 Australia–New Zealand edition of the Horizon Report published by the New Media Consortium (NMC) as having likely time-to-adoption of two to three years (Johnson, Smith, Levine & Haywood, 2010), and by the NMC's 2011 *Technology Outlook for New Zealand Tertiary Education* as having a time-to-adoption of four to five years (Johnson, Adams & Cummins, 2011). AR is a "live, direct or indirect, view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data" (Wikipedia, 2013). AR offers great promise for a greater blending of the real and virtual that will produce new educational opportunities. This is likely to include a social and multi-user augmented reality as has been seen with the development of 2D mobile social media tools. Examples of AR applications in health sciences and veterinary science education include imposing the internal anatomy of a body over that of a live video view of a real body for a simulated look inside the body or for virtual surgery practice. Students in history or archaeology could view landscapes or cityscapes to see views of how the location appeared in the past using mobile devices or HUD devices such as Google Glass, while students in architecture could view how a building design would sit in the landscape. Industrial and product design students could use AR models to assimilate their designed artefacts in 3D allowing for rapid changes such as shape, colour and texture to be done in real time. Today simple interactive AR models can be manipulated. This is done by using AR markers that are printed on paper that can be viewed through AR viewer applications showing a video feed of the scene with the 3D model superimposed in context. The user can move, rotate or block portions of the marker to produce changes in the model, for example, rotate a 3D exploded view of components of a car or tap on a virtual drum kit to produce musical tunes. Other examples include 3D car racing games that can race different users, spacecraft that can be created and moved or 3D models of shoes where users can change their attributes. Since AR can also be triggered by GPS and locative data, it can be used to reveal relationships between physical locations and other relevant information, e.g., as a navigation aid or associating indigenous knowledge with artworks on display.

Head-mounted displays

By using a head-mounted display, users will be able to fully immerse themselves in the VWs, providing the sensory illusion of actually being there. Preliminary research shows that users of devices such as the Oculus Rift have a higher perception of immersion and develop a near "haptic" feeling of virtual objects (Reiners, Wood & Gregory, under review). While such displays have been in existence for many years, their decreasing cost, size and weight in recent years have allowed them to enter the commercial mainstream. 3D stereoscopic glasses targeted at home users are now widely available for gaming and 3D video viewing purposes.

Gesture-based and other natural user interfaces

Through advances in, and mainstreaming of, 3D motion sensing technologies, gesture-based movement will become readily available so that what one is doing in the real world is enacted and represented through the avatar in the VW. Those in the VW will be able to see body language displayed through the avatars. The NMC, in its 2010 Horizon Report for Australia and New Zealand, predicted that gesture-based computing would enter the higher educational mainstream within four to five years (Johnson et al., 2010), and affirmed this prediction in the 2011 *Technology Outlook* for New Zealand (Johnson et al., 2011). The 2012 *Technology Outlook* for Australia again echoed this, though using the broader term "natural user interfaces" (Johnson et al., 2012). Empowered by such innovations, educators will be better placed to design interactive tactile learning tasks in a VW to engage students and encourage the achievement of superior educational outcomes. Haptic gloves are an example that have been around for many years allowing tactile and gesture based movements. Such devices, along with movement based sensors such as Kinect and Razer Hydra, will continue to find uses enabling VW participation to become all the more real, with many senses being used (Yeom, 2011).

Embodiment

Avatars will increasingly be capable of looking like their user and consequently immersion by students learning in a VW will become more intense. More realistic body language and animations for avatars will become mainstream. There will be easier and more intuitive ways to "trigger" avatar actions but live streaming movement is still some distance away from coming to fruition. Low-cost equipment like the Kinect and software packages like iClone can produce more lifelike body language and gestures, which enriches the interactions between avatars and provide more realistic learning opportunities.

Holographs

VWs will eventually come off the computer screen and be projected holographically, providing even greater dimension to the learning experience. Cisco recently began marketing holographic telepresence videoconferencing systems (see VanDervoort, 2013) that have the potential to greatly improve the sense of co-presence experienced by geographically distributed users.

Wearable technology
The most recent NMC Technology Outlook for Australia and New Zealand identifies wearable technology as being within the four-to-five-year adoption horizon (Johnson et al., 2013). Such technology will give people the ability to wear devices on their bodies as accessories or as part of their clothing and be inworld whilst undertaking other activities. Devices like Google Glass will enable this to occur where someone can continue to undertake their work in the real world, but have virtual inworld activities that they are participating available through their glasses. Wearable computing will be enabled as the size of computing devices continues to shrink and their power increase, allowing individuals to take a VW with them on the go.

Learning design, pedagogy and assessment in virtual worlds

Given the increases in fidelity, interaction quality and availability, the range of potential educational uses for VWs will continue to expand. In the future, the level of understanding of what is best taught using VWs would need to be more clearly defined and research-based. This body of knowledge will have built up over time and will provide a far better understanding of pedagogy and of the best utilisation of VWs for a given teaching and learning outcome.

Authentic learning
There will be an increase in pressure to ensure that research, learning and teaching will be authentic. Tasks should offer opportunities to examine problems from different perspectives, require collaboration, reflection and seamless integration with assessment (Herrington, Reeves & Oliver, 2010). Authentic tasks should have real world relevance and match it as nearly as possible. VWs are especially suitable for engaging in situated role plays (Carroll, Anderson & Cameron, 2006; Flintoff, 2009) to facilitate authentic activities. Authenticity will be bought about with more realistic storylines and assessment based on the story context and decision points. Authentic learning scenarios undertaken in VWs will provide opportunities for the learner to understand concepts and practise learning that may be impossible to do in real life.

Combining individual, asynchronous and synchronous collaborative learning
A dichotomy has emerged in that both multi-user or live synchronous activity in a VW and closed VWs where students can self-explore scenarios as many times as they like is occurring. Self-paced activities could involve the use of bots (non-player characters), machinima, or SoaS. Indeed it could be argued that taking a flexible, non-time dependent resource like a VW and constraining it is to retard its potential. However, if we were to consider the higher-order thinking processes involved when a student is given the opportunity to evaluate the inworld design of a peer, or engage in a complex multifaceted problem scenario, then the asynchronous task would have educational merit. VWs will be increasingly used for student self-practice sessions in this manner. These branches have the potential to be mutually complementary. Examples could be:

- Students performing certain activities in standalone versions of various VWs (e.g. SoaS);
- Preparing items or projects to be displayed in a location in a multi-user VW environment such as SL or OpenSim for other people to see and evaluate;
- Practicing a range of skills before launching into the bigger more chaotic multi-user environment;
- Making parts of machinima in the standalone environment for incorporation into a larger machinima that may be finished off or shown in a multi-user environment;
- Preparing individual assignments for submission to the teacher or peers for marking.

Action-based learning assessment
Learning in VWs established its importance and its place in VW studies during the last decade and consequently assessment played an important role in the process. Different projects were developed to assess students' learning in VWs. VirtualPREX (Gregory et al., 2011) is a 3D immersive virtual professional experience environment, using formative assessment to provide pre-service teachers with teaching experiences. Stealth assessment, as defined by Shute et al (2009, p. 299), is "embedded assessments … so seamlessly woven into the fabric of the learning environment that they are virtually invisible" and "can be accomplished via automated scoring and machine-based reasoning techniques to infer things that would be too hard for humans (e.g. Estimating the value of evidence-based competencies across a network of skills)". Al-Samadi et al. (2012) proposed a framework to design assessment and feedback for serious games using stealth assessment. VWs provide users with a chance of experiencing real-life situations to learn by acting in these environments. Action-based learning assessment method (ALAM) (Fardinpour & Reiners, under review) enables virtual training

environments to recognise avatars' actions, which are the reflection of human-user actions, classify these actions, and eventually analyse and evaluate them. ALAM uses an open taxonomy to be applicable in every 3D virtual environment and action recognition system. Currently, action-based learning assessment is used in virtual training environments as a specialised form of VWs, but this assessment method, or its components, can be extended and adapted into different virtual environments such as games, VWs, virtual learning environments, and virtual training systems. Immersive technologies have dramatically developed in recent decades. From the first uses of virtual reality in early sixties (Pimentel & Teixeira, 1993) to today's advance immersive technologies, the main idea was to immerse users into a VW and provide them a life-like experience in learning, entertainment, business, etc. Modelling, together with analysing human behaviour, performance and skills via VWs, needs the identification and evaluation of conducted actions. This is the significant contribution of ALAM as well as the taxonomy of actions in virtual training environments, to the future advancements in VWs.

Anonymity
The ability to have an anonymous avatar will continue to be the choice of the user. Many educators insist on their students having avatars that are not known to others for authentic role-play activities, such as playing the role of a primary school student in a teaching practice scenario (Gregory, 2011); or so that the student can state how they feel without the knowledge that others know who they are. This is sometimes important for the more shy students who will often, in a live classroom situation, avoid participating in classroom discussions due to various reasons, including the perceived risk of – ridicule, lack of confidence or not wanting to stand out. Anonymity can assist in avoiding these feelings.

Simulations and scenarios where immersion elements are important
VWs will be able to provide simulations in difficult situations students may possibly face in their careers. This will include complex interpersonal scenarios that will equip graduates of the helping professions with interpersonal skills developed at a higher level for increasingly complex working environments.

Game-based learning and gamification
The next few years will see greater convergence between VWs and games, with more widespread acceptance of gamification in teaching and learning. Game-based learning appears under the "two to three years" time-to-adoption section in two NMC reports (Johnson et al., 2011, 2012). It seems likely that immersive game environments will be leveraged towards learning activities – the shifts in the Minecraft community already reflect this (Reiners et al., 2012). VWs such as Minecraft can be used in all levels of schools and there will be a shift towards these types of worlds. A simple interface with minimal user investment will continue to greatly facilitate the ad hoc user, especially where inworld person-to-person interaction is the intention and the virtual space need not be very complex. A whole range of VWs will become ubiquitous such as the Internet is now. Game like VWs have become accepted.

Scalability and interoperability of virtual worlds

Currently the majority of content that is created in a particular VW is locked into that space. In line with the open access movement in other areas of scholarship and education in the future, strategies will be developed and technologies increasingly chosen for their ability to share content across the education community. There will be easier movement of avatars, builds and artefacts between VWs that will encourage economies of scale in the education resource development space. Work with open standards and build techniques with such tools as OpenSim, SoaS and meshes will allow us to more towards achieving that goal.

Open access/integration
Trends towards open access and open standards in education communities will lead to there being "Open Access" virtual repositories where designs for virtual spaces, re-usable components for building virtual spaces, software tools, pedagogical designs, lesson plans and the like can be shared, taken, tested and improved upon (Boyd & Ellis, 2013). Similar such repositories for 3D CAD files are already being used by the additive manufacturing movement sharing or commercialising their designs for 3D environments or 3D printers. Lack of standardisation of formats is limiting the direct transfer at the moment; yet merging is anticipated for future applications. Verification of 3D objects in VWs before printing, enhancing documents with 3D designs, or having 3D objects as gifts in social games are just a few examples benefiting from a common standard for encoding 3D models. Ideally there should be no limitation on inworld tools. VWs should move for greater integration to third party applications such as OpenOffice or Skype, social networking tools and Smart Boards. The move towards the use of open technology standards could assist this process but it remains to be seen in light of proprietary vendor interests. It may take open source alternatives to spur this on just as OpenSim has proved an alternative pathway to sharing WV objects and builds.

Scalability
There will be greater ability to tailor the size and constraints of the virtual space to suit the learning task. When a great number of users interacting at the same time or a free roam approach is favoured, then the current offering of "worlds" suit well. When tasks like role-play are the goal, perhaps smaller discrete virtual spaces are better suited. Being able to offer bespoke discrete virtual spaces is currently available via SoaS and Jibe, but we should see more design and intent built with this in mind.

Machinima
Machinima will continue to have a place in VW teaching. The use of machinima enables students to learn through VW technology without students having to log into the VW and participate in activities. A good example of this is the work done in Queensland University of Technology in Law (Butler, 2012), Central Queensland University in Accounting (Muldoon, Jones, Kofoed & Beer, 2008), University of New England in Pharmacy (Gregory et al, 2012) and the University of Western Australia which hosts the largest machinima competitions in SL (Highley & Jegathesan, 2013). Machinima is affordable when the $1800 annual cost of a SL island (taking into consideration of the 50% educational discount) is apportioned across students over several years – and is more affordable than real life video for producing simulations (or even less if VWs like OpenSim are used). Individual academics can use machinima as a cost effective, broad canvas for the creation of simulations and authentic learning environments. This compares favourably with real life video which requires substantial funding and be limited in terms of the locations that are practically available (Butler, 2012). Machinima is a cost effective means to contextualising abstract principles, to depict scenarios that resemble situations that students may encounter in real world practice and provides a context for future students who may use a VW as a teaching resource.

Conclusion

The present sees VWs at somewhat of a crossroads facing a number of obstacles such as the lack of familiarity of academics with VWs technology, lack of awareness of its affordances, general IT literacy of the academic and student populace, professional development/training availability, institutional infrastructure blockages, ease of use (or not) of the tools available to build VW spaces (especially by the average academic), little institutional intent or guidelines for curation of VW assets, bandwidth availability for those not on broadband or multiple users in one area, along with the inherent technological/physics limits to mobile/wireless bandwidth. Given these factors, it is likely that over the medium term, the proponents of VWs in education need to be concentrating on having VWs work on current and near term hardware (PCs, iOS/Android tablets) that are in student homes and academic environments now. However, research and knowledge will forge on. Specialist applications will see cutting edge input and visualisation technologies move forward and while these may well be hampered in the medium term by more mundane factors such as "fashion" (as it has done for countless clever devices in the past) for use outside of a lab, eventually these will reach the stage of a light weight Google Glass style interface at which point they will make their public debut. Over time, VWs will become increasingly accepted by institutions as part of the educational landscape and improvements in the usability, compatibility and mobility of VW technologies will allow increasing numbers of academics take advantages of what VWs have to offer. The advances expected in the fidelity of the technology, the ability for multiplicity of expected access opportunities via the use of natural interaction and mobility coupled with an increase in pedagogical knowledge will ensure a strong future for VWs in the teaching and learning arena.

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Author contact details:
Sue Gregory, sue.gregory@une.edu.au
Brent Gregory, bgregory@une.edu.au
Torsten Reiners, t.reiners@curtin.edu.au
Ali Fardinpour, Ali.Fardinpour@postgrad.curtin.edu.au
Mathew Hillier, m.hillier@uq.edu.au
Mark J.W. Lee, malee@csu.edu.au
Lisa Jacka, lisa.jacka@scu.edu.au
Des Butler, d.butler@qut.edu.au
David Holloway, djh258@uowmail.edu.au
Scott Grant, scott.grant@arts.monash.edu.au
Merle Hearns, Merle.Hearns@manukau.ac.nz
Kim Flintoff, k.flintoff@curtin.edu.au
Jay Jay Jegathesan, jay.jay@uwa.edu.au
David Ellis, david.ellis@scu.edu.au
Marcus McDonald, marcus.mcdonald@rmit.edu.au
Frederick Stokes-Thompson, Frederick.Stokes-Thompson@unisa.edu.au
Belma Gaukrodger, kiwibelma@gmail.com
Jason Zagami, j.zagami@gmail.com
Chris Campbell, chris.campbell@uq.edu.au
Xiangyu Wang, xiangyu.wang@curtin.edu.au
Jamie Garcia Salinas, jaime.garciasalinas@uqconnect.edu.au
Swee-Kin Loke, swee.kin.loke@otago.ac.nz
Sheila Scutter, sheila.scutter@jcu.edu.au
Christine Newman, christine.newman@qut.edu.au
Ning Gu, Ning.Gu@newcastle.edu.au
Stefan Schutt, Stefan.Schutt@vu.edu.au
Helen Farley, Helen.Farley@usq.edu.au
Anton Bogdanovych, A.Bogdanovych@uws.edu.au
Tomas Trescak, tomi.trescak@gmail.com
Simeon Simoff, S.Simoff@uws.edu.au
Caroline Steel, c.steel@uq.edu.au

Penny Neuendorf, Penny.Neuendorf@cit.edu.au
Matt Bower, matt.bower@mq.edu.au
Lindy McKeown Orwin, Lindy.McKeown@usq.edu.au
Tom Kerr, tom.kerr@mq.edu.au
Ian Warren, ian.warren@deakin.edu.au
Denise Wood, Denise.Wood@unisa.edu.au
Charlynn Miller, c.miller@ballarat.edu.au
Shane Mathews, sw.mathews@qut.edu.au
Dale Linegar, dale@oztron.com
Vicki Knox, vknox@une.edu.au
Yvonne Masters, ymasters@une.edu.au
Ross Brown, r.brown@qut.edu.au
Grant Meredith, g.meredith@ballarat.edu.au
Clare Atkins, Clare.Atkins@nmit.ac.nz
Angela Giovanangeli, Angela.Giovanangeli@uts.edu.au
Karen Le Rossignol, k.lerossignol@deakin.edu.au
Andrew Cram, Andrew.Cram@acap.edu.au
Eimear Muir-Cochrane, eimear.muircochrane@flinders.edu.au
Arin Basu, arindam.basu@canterbury.ac.nz
Michael Jacobson, michael.jacobson@sydney.edu.au
Ian Larson, ian.larson@monash.edu

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