



New applications, new global audiences: Educators repurposing and reusing 3D virtual and immersive learning resources

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There continues to be strong interest among established, experienced academic users of 3D virtual environments for their sustained educational use. Consistent with global trends, they plan to further develop and optimise existing applications, reuse skills and experiences gained to develop new applications, and to share and reuse existing virtual resources. This is against a background of varied support from institutions, colleagues, students, funding bodies and also changing understanding and awareness of virtual environments and virtual reality by the general community as a result of consumer developments such as the popularity of multi-user online role playing amongst both children and adults, and the acquisition of technologies by companies with deeply entrenched technologies. At the same time, the ongoing development and availability of

new multiuser virtual environment platforms, associated peripherals and virtual reality technologies promise new and exciting opportunities for educators to collaborate with researchers on a global scale, while also exploring the affordances of these technologies for enhancing the learning outcomes for an increasingly diverse and distributed student population.

Keywords: 3D virtual worlds, immersive learning, repurposing, reusing, virtual environments

Introduction and background

The Australian and New Zealand Virtual Worlds Working Group (VWWG) was established in 2009. Since then, members of the VWWG have written papers for the ascilite conference providing an update on the educational use of virtual worlds across the two countries. This year, following similar interest globally, and in keeping with the New Media Consortium (NMC)'s (Johnson et al., 2015) anticipated growth in the use of flipped classroom approaches and the educational applications of wearable computers, 'Makerspaces' and the 'Internet of Things', Australian educators are beginning to explore the potential of repurposing and reusing 3D virtual and immersive learning resources to harness augmented spaces. A survey was sent to group members and 30 members, from 24 different institutions across Australia and New Zealand, provided feedback in relation to their current use of 3D virtual and immersive learning environments and, in particular, how they are repurposing and reusing learning resources, including objects, environments and pedagogical approaches.

Members of the VWWG provided several standout points to consider. A wide variety of applications were reported as being used through 3D virtual immersive environments across a range of disciplines. There is also a broadened definition of virtual worlds to now encompass 3D virtual environments that include some platforms not traditionally seen to fit the virtual world category such as *SketchUp* and *Google Earth*. The reduction in cost of additive technologies and use of other technologies such as 3D printers has broadened the applications of virtual environments through a combination and convergence of these technologies. There is also increasing focus on finding ways, formats and platforms that allow greater sharing of resources. The limitations of some platforms (e.g. hard to use/develop technically, too costly, closed systems, etc.) are pushing academics to explore alternative platforms. In the past, there has been a lack of easily transferable virtual resources, limiting sharing of pedagogical designs and virtual resource development skills across platforms. With the anticipated continued growth in the open education resource movement, finding ways to collaborate and share resources and knowledge globally will be an important goal if educators are to more effectively engage learners in the use of these environments in ways that enhance learning, teaching and assessment outcomes in a sustainable manner.

Literature Review

Immersive environments have provided instructional, autonomous and collaborative capabilities to support the creation of educational materials and are best grounded in pedagogy rather than being solely driven by the latest technology (Price, 2011). The pedagogical principles underpinning adoption have applied equally to virtual and immersive worlds, single and multi-player environments and related virtual technologies. Identifying the desired learning outcomes is fundamental in shaping effective learning designs for virtual spaces, whether they utilise autonomous learning activities, teacher led activities or participatory group experiences. Since the mid 1990s, virtual worlds have supported a diverse range of activities, including: experiential learning (Jarmon 2008; De Mers, 2012); student perceptions of learning in virtual worlds (Lowe & Clarke, 2008; Huber & Blount, 2014); engagement with specific disciplinary material (Herold, 2009; Lee, 2009; Pereira et al., 2009; Beebe, 2010; Teoh, 2012); supported training and role-play (Gregory et al., 2011; Gregory & Masters, 2012a, 2012b; Neuendorf & Simpson, 2010; Slator & Chaput, 1996) or introduced multi-player 3D games used to stimulate debates and discussion between peers on authentic or complex topics (Brom, Sisler & Slavik, 2009). Drawing on an extensive review of research and field notes from virtual learning environments, Jarmon (2012) found that 3-D virtual environments, in whatever form, would be increasingly used as knowledge and social interaction management tools in the foreseeable future.

The modality of game-based learning is an emerging area of influence with approaches available to create dynamic pedagogical agents of intrinsic motivation, mediated communication, supported self-representation, sensory abilities or situational context responses (Leung, Virwaney, Lin, Armstrong & Dubbelboer, 2013). The use of virtual worlds and mixed reality, coupled with game-based mechanics, is bringing new opportunities to 3D immersive environments (Callaghan et al., 2013; Charles et al., 2011) with game-based learning activities able to drive experiential, diagnostic and role-play learning activities (Toro-Troconis, et al., 2012). Virtual worlds provide opportunities for grounded experiences situated in understanding both practices and content as learners experience the consequences of actions based on inquiry and/or gaming contexts (Vrasidas & Solomou, 2013).

Virtual environments can bring geographically distant students and staff together to provide a connection with the main campus. Universities around the world have created thousands of satellite campuses, both domestically and internationally, with the promise that distance is no barrier in obtaining a high quality education (Leung & Waters, 2013; Waters & Leung, 2013). Eaton et al. (2011), provide one such example, linking 16 campuses with 200,000 students and 7,500 staff using *Second Life*.

Despite continued optimism by educators and researchers across disciplines who see value in virtual worlds due to their immersive nature and global reach, a range of challenges continue to hamper their wider use. These challenges include the complexity of technology development, forced updates by vendors, ongoing costs, and a reliance on grant fixed term funding. Vendor and client-side system functionality and structures are still plagued by high levels of uncertainty in development cycles, as well as being complex and difficult to operate for non-technical users (Gupta et al., 2014). Educators need to reuse skills and experiences and share strategies and resources in order to remain responsive to the still emerging nature of 3D immersive virtual environments. It has been argued that the community of practice around virtual worlds in education had done much along this path and that now is an opportune time to work toward the 3rd generation of virtual world tools (McDonald, Gregory, Farley, Harlim, Sim, & Newman, 2014). McDonald et al. demonstrated that mitigating many of the issues stated above would allow virtual worlds to continue up Gartner's Slope of Enlightenment. This has indeed been the case in moving from the 'Trough of Disillusionment' in 2013 (Lowendahl, 2013) to the 'Slope of Enlightenment' in 2014 (Lowendahl, 2014) and then towards the 'Plateau of Productivity' in 2015 (Lowendahl, 2015).

Rapid growth in consumer technologies, wearable computing and the use of technologies to facilitate creativity and innovation through the collaborative development of digital artefacts ('makerspaces'), combined with the on-going rapid expansion of game types, platforms, experiences and media-convergence, compels educators to address the challenges, opportunities and potential of 3D virtual environments for more effective use of blended learning approaches to facilitate flexible learning in augmented spaces (Johnson et al., 2015).

Method

Members of the VWWG participated in an online survey focussed on changing audiences and applications as well as the repurposing and reuse of 3D virtual and immersive learning resources. Of the 183 members invited, a small sample of 30 (16%) completed the survey. The small sample size of respondents is due to the specialised nature of this group. Demographics, including discipline and audiences taught (student, staff or other) were also collected. The survey data was manually coded into themes and then the NMC Report (Johnson et al., 2015) themes provided a lens through which member responses, relating to how they are repurposing and reusing using 3D virtual and immersive learning resources, could be analysed. These themes include: important developments in educational technology in higher education; significant challenges impeding technology adoption in higher education; and key trends in accelerating technology adoption in higher education. The findings from the study are reported in the following section.

Findings

To provide an overview of how the members of the VWWG are using 3D virtual and immersive learning resources, respondents were asked to provide information on the ways in which they have been using these spaces (see Figure 1), and the disciplines of use (see Figure 2). Members were able to nominate more than one way in which they were using 3D virtual and immersive technologies

(see Figure 1). Research activities undertaken by educators were the main ways in which these spaces were reported to be used by members of the VWWG, closely followed by simulations, machinima, role-plays and presentations.

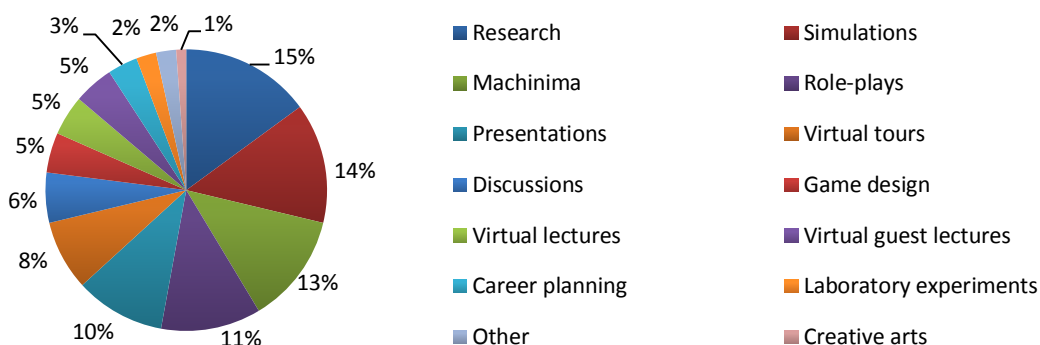


Figure 1: Discipline and/or non-teaching areas being used

Ways in which 3D virtual and immersive environments are being used

To provide context, members were asked ways in which 3D and immersive environments were being used at their institutions with respondents reporting a variety of ways. These responses are clustered into four main themes including: the different types of learning and teaching pedagogies incorporated into their learning, teaching and/or research spaces; the various types of learning and teaching activities undertaken; the types of spaces created; and how they were used to interact with others. Table 1 provides an outline of activities within each theme.

Table 1: Overview of ways VWWG members use 3D immersive environments

Pedagogical approaches used
Types of learning teaching activities
Creation of spaces/ teaching resources
Interaction with others

Transformative, experiential and contextual learning, problem solving, game-based learning, task-based learning, integration of gamification	Teaching, training, discussion of learning materials, presentations, assessment, role play, scenario practice, treasure hunts, web quests, building, scripting, simulations, laboratory procedures, combining histories with actual site reproductions, self and peer review of performance, rapid prototyping, phobia modelling and physiological response tracking	Designing, demonstration of business models, creating elements of authentic learning that enhances situated learning, collaborating to create machinima, developing resources and interactive activities	Meetings, remote tutorials, community of practice, orientation, resource centre, advertising, international events, presentations, teaching across campuses, career development, conferences, socialising, research
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In relation to the discipline (Figure 2), members of the VWWG reported that they were using 3D virtual and immersive learning spaces (more than one discipline could be nominated) in education (most often reported), health and business. Other responses included medicine, statistics, climate change, health and safety training, multimedia, film, information systems, orientation and engineering. The disciplines in which members reported that they least use these spaces, including “other”, were history, law, visual and performing arts, information technology, tourism and pharmacy, with no responses from hospitality, indicating that it was not being used by any of the current members of the VWWG who completed the survey.

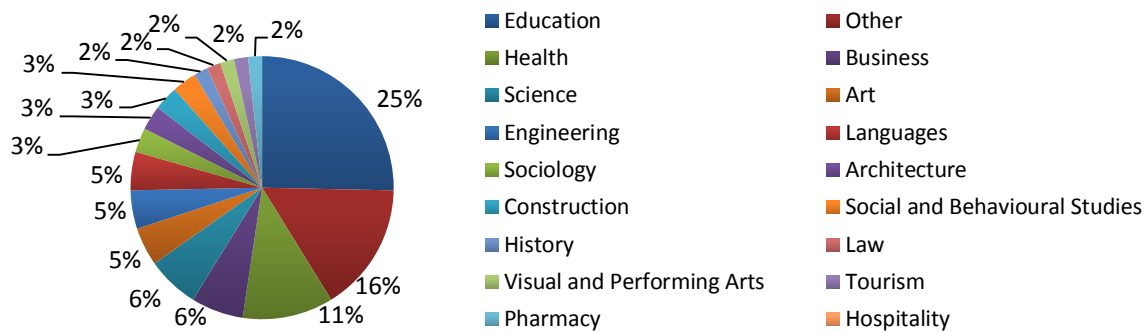


Figure 2: Disciplines in which VWWG members are teaching using 3D immersive virtual environments

Teaching audiences

Respondents were also asked to indicate the number of staff, students or other (which included users outside their institution) who were their teaching audience/s. Table 2 provides an overview, indicating that the largest audience was their students. Members were also asked to indicate if their teaching audiences had changed from the past, with 31% indicating that they had. The majority, 69%, stated that they were still using 3D virtual and immersive spaces the same as they had in the past.

Table 2: Teaching audience and type of variation

Type of teaching audience	Percentage
Staff	15%
Students	59%
Other	26%

Teaching audience different from the past	Percentage
Yes	31%
No	69%

As indicated in Table 2, the audience reported by the majority of respondents is students, followed by colleagues, then professional staff through collegiate and global connections facilitated by specific projects. Students enrolled in courses utilising 3D and immersive technologies include a mixture of undergraduate and postgraduates, including PhD candidates, as well as those studying at TAFE, or pathway students who are undertaking enabling courses. There has been a focus in some institutions on offering training for workers within industry groups (for example in the mining and construction sector for health and safety training).

Change of audience

VWWG members who indicated that their teaching audiences had changed in the past year were asked to explain why this change had occurred. Respondents stated that they were now doing things differently, with little work with students directly, their research had been completed, or the uptake from other staff had not occurred. However, others felt their audiences had expanded because the use of 3D virtual worlds was no longer limited to communication or visiting places. These virtual environments now offer enhanced interactivity and authenticity. Consistent with NMC report findings (Johnson et al., 2015), flipped classrooms and blended learning are being used more extensively enabling a more flexible approach to learning and teaching. Several other members stated that their audiences had extended in reach beyond their normal disciplinary field. Others reported the use of these environments to facilitate community engagement, such as projects involving students with disabilities and those with chronic illnesses, seeking to enhance the social and communication skills of these groups.

Repurposing or reusing 3D virtual and immersive learning objects and environments

VWWG members were also asked to indicate how they were repurposing or reusing 3D virtual and immersive environments. Their responses were able to be categorised using NMC 2015 themes (Johnson et al., 2015).

'Makerspaces'

In a design and technology education context, the use of *SketchUp* as a virtual environment has not only enabled the visualisation of designs in a 3D form, but also in combination with other geographical technologies such as *Google Earth*, to develop and model designs. A virtual 3D modelling capability is cost effective as certain design problems can be modeled virtually with no resources being used. In recent years, the reduction in the cost of 3D additive and subtractive manufacturing technologies has enabled designers to take that next step in the design process and realise their design prototypes and has made these technologies, such as 3D printers, very accessible. This growing area of interest is again consistent with the NMC report's predictions that the use of technologies to facilitate innovation and creative skills through 'Makerspace' environments are likely to gain greater traction within the coming year (Johnson et al., 2015).

Cross-institutional collaboration and open education resources

Collaboratively, Australian and New Zealand universities' colleagues are exploring ways in which to share resources. As the textbooks and curriculum of the New Zealand students are slightly different from those in Australia, members are looking to re-purpose existing virtual resources for use with other institutions' materials, as well as make their pedagogical materials available for use. Resources have been developed for creating, sharing and storing 'learning objects'. This is in line with NMCs long-term trend of increasing cross-institutional collaboration (Johnson et al., 2015, p. 2).

3D models off the rack are often purchased when possible. For construction, this is possible, but much more difficult in specialised fields such as pharmaceutical science. Many members access material in *Second Life* that has been created by other colleagues around the world. There is a vast resource pool which is easy to find and use rather than resorting to continually creating new artefacts. Using these tools makes it easier for students to understand the systems when they see them in operation. Other members have created their own resources to share across various virtual worlds. Often, the resources/objects/environments are completely self-contained, sometimes including the use of Heads Up Display (HUD). Many objects purchased from other creators have come with limited IP rights that are manifest in restrictive permissions assigned to 3D objects, raising barriers to sharing. An alternative is to recreate each object from scratch to ensure that there are no IP right issues, however this is labour intensive and inefficient. But, at the same time, this is the only alternative in some cases.

Many members report that they are not sharing their simulation work even though general 3D virtual spaces have been created from existing resources and many are utilising open and free objects within *Second Life* to construct larger builds. Assets created within *Second Life* for clinical education and role-playing spaces have, to some degree, been packed up and then reused for projects of similar need. However this has proved difficult and inefficient. This is especially so when virtual land has been unfunded or closed. Builds using open platforms (such as *OpenSim*) rather than in closed eco systems (such as *Second Life*) allow packing of objects in inventory archive (IAR) files or whole sims in *OpenSim* archive (OAR) files, which are then are placed online for others to download and use. Increasing cross-institutional collaboration and extending sharing of resources and pedagogical practices are similarly identified in the NMC report (Johnson et al., 2015) as global trends, which pose significant challenges, hence the report's prediction that achievement of such goals may still be five or more years away. 3D scanned objects can be created for reuse; for example, authentic spaces can recreate the shape and surface markings of an Egyptian tomb so that scanned objects can be placed within it, providing further context for excavation techniques and object descriptions.

Teaching complex thinking and creative problem solving

The NMC 2015 report (Johnson et al., 2015) suggests that the teaching of complex thinking will become increasingly important in the next two-three years. Although the NMC report describes complex thinking as beyond creative problem solving and decision making, suggesting complex thinking will require graduates who are able to manage 'big data' and be able to take advantage of the latest tools and techniques to solve complex problems and influence systemic change, several VWWG members report using 3D virtual and immersive environments to foster critical thinking, creative problem solving and clinical decision making. Multiple sources of information such as patient case history, blood test results, ECG, radiology information (such as MRI, CT or ultrasound images, etc) are being used for clinical decision-making. Students make informed decisions by selecting the correct objects in the right sequence. The clinical tutor is available to assess/challenge student knowledge and understanding. Students are located all across the continent so the virtual meeting space is ideal.

Machinima is being utilised to support learning in areas as diverse as law, accounting, pre-service teacher education and climate-related decision making. Machinima, using techniques akin to film or television shows (including detailed set dressing, multiple camera angles and post production sound effects), can be utilised to depict complex and engaging narratives for learning. When combined with simulated documents they are capable of creating immersive environments which is an important success factor in online and technology-based learning. Students are inspired to learn by such environments because they are involved in authentic tasks such as negotiation, interpretation of documents and evaluation of evidence, and can appreciate the relevance of what they are studying to their future careers. Moreover, unlike clinical programs, such learning environments are scalable and can offer the same realistic learning experiences for large cohorts of students, regardless of mode of study. It is a cost effective alternative to real world video for educators in the context of limited financial support for development of multimedia resources. Machinima produced by students as evidence of learning can be curated and used as exemplars or resources. Machinima tasks have a real world focus with activities that closely replicate those undertaken by professionals in practice.

Existing resources are also being reused for language learning and teaching purposes in *Second Life*. Objects can be adapted for language practice. *Second Life* still has the largest community of language learners and volunteers. The use of VWWGs for language learning provides students with the opportunity to communicate and collaborate with peers globally while also fostering their ability to use language in ways that support critical thinking in authentic contexts.

Convergence of wearable computers and consumer technologies

The NMC report (Johnson et al., 2015) predicts that wearable technology will see significant growth in the coming year and will increasingly be applied in higher education. Several VWWG respondents reported that they already utilise wearable technology in their teaching and research. In particular, the use of the Oculus Rift has been used to immerse students and/or staff during training and professional development sessions.

The current trend in teaching in 3D immersive virtual environments has been through the integration of gamification; i.e. the distinction of gamification and serious gaming and how this can be represented in virtual 3D environments. Serious gaming enables the modeling of complex bodily functions and for players to explore within the confines of game mechanics. Students appreciate a well-designed simulation that is both fun and also assists them to build knowledge in an assessable area. Game design is important when gamifying online interactions; however, finding the best solution to encourage site exploration and deep learning is difficult. By using game engines, many assets created outside of those environments can be easily shared. The languages used to drive most 3D engines are similar if not the same. 3D immersive virtual environments have been used for refinement via the introduction of a few new mechanisms for engagement. Consideration of how the spaces are revitalised to allow more independent engagement whilst still providing meaningful scaffolding and feedback via automated mechanisms has been explored. Many existing virtual worlds have the potential to be converted to be more game-like as a simulation. NMC reported the relevance of gamifying learning for students (Johnson, et al., 2015).

Teacher education – transference of skills across platforms

The virtual world of *Twinity* has been used to ascertain whether skills that are learned in *Second Life* and activities that had been used there could be transferred to another virtual world. In terms of the social presence of virtual worlds that helps to support first year transition, *Twinity* was very successful. Part of what has been tested was the difference between synchronous meetings in a virtual world and those held via webinar software with students. As both were done via typed chat rather than voice, there was a distinct similarity in method of learning and teaching, but the webinar did not have the same visual impact as the virtual world. Students commented both in chat and evaluations about the positive interactivity of *Twinity*. *Sim-on-a-Stick* has been used in primary schools to demonstrate to pre-service teachers that it was possible to use the technology in the school environment. In so doing, sharing of objects and environments between primary school students and schools takes place. Primary school builds were taken into the virtual world to create a learning space for pre-service teachers so they could see what was possible for children to produce and learn to build.

Research

Much research has been undertaken in 3D immersive environments and here we provide just some examples of what members of the VWWG have used them for. One research study relates to the use of virtual environments by young people who have Autism Spectrum Disorder, particularly in terms of developing their socialisation skills. The *Virtual Lab* is premised on developing both social skills and personal interests in technology, so the platforms used vary considerably. The most common 3D immersive environment used is Minecraft, especially by the younger groups, with older groups using *Unity 3D*, *Unreal* or other 3D game engines, as well as specialist game creation tools such as *Sploder*, *Game Maker* and *RPG maker*. Lab mentors (who are programmers and designers) help participants create their own games and develop both social and coding skills. 3D virtual worlds are used as learning tools for improving socialisation and IT skills rather than for their own sake as teaching environments. Some of the software being used, such as *iSee*, does not provide sharable objects with the exception of maps, which can be shared. This is the concept of combining entrenched technology (e.g. webcam conferencing) with more recent technology (e.g. 3D virtual environments). This allows users to obtain a greater sensory experience by feeling more engaged with other participants (Safaei et al., 2014). Research in the area of intercultural competence and study abroad suggests that students benefit more if they have prior experiential learning to raise awareness of their world-views and identities. *Second Life* is proving to be a very useful tool for this as it challenges assumptions and stereotypes, highlighting ways of communicating and developing resilience, critical reflection and deep learning. Research is the backbone of the NMC report (Johnson et al., 2015) and the VWWG community continue researching to ensure that they have the evidence to support their findings.

Challenges and how they have been overcome

The NMC report (Johnson et al., 2015) documents several challenges facing educators over the coming five years and beyond. These challenges include blending formal and informal learning and adapting to the convergence of a range of technologies, digital literacy, teaching complex thinking and competing models of education. Several of these challenges are evident in the responses from the VWWG community documented in this section.

One of the major challenges reported by members has been the cost of purchasing and developing the 3D immersive virtual environments and keeping up with the shifting landscape. These challenges have not yet been overcome in all institutions. With some institutions, central support and technical problems remain the most significant problem and without grant money, development is almost impossible. The level of digital literacy of students remains a significant problem also, making off-campus use of 3D immersive virtual environments more work, as different pedagogical approaches require exploration. Access for students remains a key issue where not all students have quality Internet access. At this stage it is not possible to make virtual world engagement compulsory in courses for that reason. However, some participation is compulsory where computer technology can be guaranteed, such as for on-campus students or students outside the campus who have the required technology.

Software based on a *Cube 2* engine, and developed by an independent group of educators has also been used, though development and support for this software has been haphazard at best. The limitations of the program often remain unaddressed, despite a large user community. These limitations include the lack of a truly web-based platform for delivery. Other platforms have been explored as a means of achieving the same outcome, such as Minecraft, but the compromises required, including sacrificing authentic surface-mapping for game-play, seem difficult to overcome.

General recognition that virtual worlds have a place in higher education has been a challenge for members of the VWWG. Virtual world affordances and advantages have not been well articulated. There is also a general impression that virtual worlds (as associated with *Second Life*) are 'done' and 'last year's news'. This may not have been helped by the extreme over hyping of virtual worlds. There is still a perception that virtual worlds are in the 'Trough of Disillusionment' to the point they are a 'dirty word' in some areas. Last year's move up the Slope of Enlightenment (Lowendahl, 2014) does not seem to have filtered through and bolstered popular perception of virtual worlds in education. There is currently a lack of recognition by university management in wanting to fund any work in this area. One of the initial challenges was skepticism about the value of using virtual worlds. However, once used for a while, people were able to see why they were beneficial. There has been

a lack of support from many institutions and pre-conceived ideas from students and staff about the value of virtual worlds in relation to teaching and learning. Sometimes this has included constant restructuring and downsizing, which made it difficult to build alliances and partnerships with colleagues in the area of education technology innovation. This has been overcome by working largely outside institutions.

External scripters and modellers have been hired to do a lot of work to develop some virtual environments. The costs involved are often high and have limited what can be done. To overcome this, members have undertaken to learn as much about these areas as possible so that there is flexibility to continually develop new ideas, new projects and to optimise current virtual resources. Some items that could be used as part of learning and teaching needs can be purchased ready-made from the *Second Life* market, but they are often only able to fulfill part of specific needs and therefore need to be modified. Sometimes these objects can lack the permissions necessary to carry out modifications. These types of items also cannot be transferred to other virtual world platforms such as *OpenSim*. More often than not, members have developed these items themselves, or where funding is available, people have been hired to develop them.

Barriers and/or enablers for sharing and/or reuse of 3D virtual world objects/environments

Familiarity with a virtual environment can be both an enabler and barrier for object sharing. Those who use the same 3D engines are more likely to do more sharing than developers using a different platform. Object formats, such as those used in 3D animation programs, need to be standardised in the same way as audio, graphic and video files. The following list identifies enablers and barriers for sharing or reusing 3D virtual world objects and/or environments. The list of barriers is much more substantive than the enablers.

Enablers

Members valued that free objects are available in virtual worlds such as *Second Life* and *OpenSim* and that creators of these objects are willing to share. Many objects purchased in these environments, either for free or for a small fee, are provided with permission to enable these objects to be reused or modified. Members also value world-editing software that enables cut-and-paste operations or 3D volumetric object creation between worlds. These digital assets can also be exported easily and saved as single files, including entire worlds. The availability of more open systems providing mechanisms for sharing objects within and beyond given grids or networks is valued. The virtual world community collaborates and shares common teaching and learning tools, often due to being open source. Mailing lists alert educators as to who may have objects available for reuse.

Being part of the virtual world community helps educators with regards to sharing virtual world objects, within networks such as the VWWG. Communities of practice have been established and connected outside virtual worlds, such as via blogs and social media, and even attending conferences in person is highly valued. An increase in the quantity and quality of research completed and reported by virtual world educators is an enabler, and finding someone who is willing to mentor has always been valued by VWWG members.

One of the biggest enablers is the increasing power of mobile technologies in making virtual worlds accessible to more people than ever before. This makes virtual world education highly mobile/portable and accessible.

Barriers

Unfortunately, many barriers remain to repurposing and reusing 3D virtual objects and environments. The reasons are myriad and many are presented here. Potential users are often unaware of what is available to modify and reuse. Some users are still unwilling to share their objects and/or environments. Many objects are of poor quality or are unable to be modified. While many ready-made items may be suitable for use in educational scenarios, they often lack the rights to be transferred to other platforms or even shared with other educators on the same platform. Often creators who offer their items for sale in, for example, *Second Life*, are not willing to customise their items for more focused educational use or to allow transfer to other platforms. This rigidity means that items cannot be used and have to be created from scratch. Sometimes, when a world/space disappears, the assets go with it because the user was unable to save a copy from the designer.

Time was reported by many members as a major barrier, such as a lack of time to search available resources in virtual worlds, a lack of time to train staff in the practice of using the virtual world. Also, there is still a lack of common infrastructure, language and repositories for sharing. Some members also felt that being able to 'sell' things in *Second Life* for 'real money' may actually provide a barrier to sharing. Facilitating cross-institutional sharing of resources are considered more challenging barriers to overcome in the longer term, anticipating this process may take more than five years to resolve (Johnson et al., 2015).

Integration of scripts from different objects has been seen as a barrier. Scripts on objects function well within specific objects, but shared communication between objects relies on overall similar communication strategies.

The major issue with the virtual world of *Second Life* is it is a closed system, i.e. objects are not likely to be exported to other systems. Therefore, more developments have a single purpose and functionality. Scripts could be used in other objects, however it was not straightforward and management is very limited. Without an established user-base or support community, development of a 3D immersive world can easily get bogged down in the need to solve multiple small problems. Having an easy way to distribute the world online can quickly indicate whether it was truly viable as a means of doing effective online learning. However, it was felt that both closed (*Second Life*) and open (*OpenSim*) virtual worlds still require considerable technical skill to use/build and so are beyond the practical reach of many academics without investing considerable time in learning the technical details. This is a medium-term priority consistent with the NMC report's anticipated more widespread adoption and acceptance of the sharing of open resources within the next three to four years.

There is general public perception that virtual worlds are predominantly for gaming rather than education. Some members felt that students should be encouraged to develop virtual worlds using gaming techniques. Getting talented developers has always been seen as a barrier and users need to identify others with sufficient levels of skill to undertake the various tasks individuals have in mind. This has been difficult, both from the perspective of availability and interest, and also cost.

Institutional barriers have been discussed for many years. Members are still frustrated that many of the barriers have not been removed over time. These continuing barriers include the cost to the average consumer in terms of time and money; inappropriate infrastructure by having only one lab in the whole institution set up to run virtual worlds; security/firewall issues; locked down hardware/systems on campus; an 'off the shelf' policy from the management of IT support services who just want to 'buy the license' to solve pedagogical/technical/ procedural issues; centralised training, knowledge and financial support; lack of funding and foresight; and an inability to think outside of the box.

One major institutional barrier reported by many respondents was that it was difficult to get virtual worlds accepted alongside other online learning environments within their institutions. Institution level understanding and support to develop 'mainstream' approaches was required. It was also difficult to get other faculty members involved and obtaining the continuing support of management. Recognition and support for the specific values/affordances of virtual worlds were required. The NMC report describes the challenge of providing appropriate reward and recognition for educators undertaking innovative learning and teaching as one of the 'wicked problems' on the horizon to be addressed in the longer term.

Some respondents felt that promoting machinima as an alternative to traditional videos for presenting messages and aiding decision-making was a way of overcoming many of the barriers to using virtual worlds within their institutions. Many academics could use machinima as an alternate method to using a virtual world with their students yet still provide the immersive experience that these 3D environments offer. By the use of machinima, convincing some colleagues of the value of such learning environments, when they have personal ideologies that do not embrace such methods, may be easier.

Conclusions

A concerted national push to raise the profile of the 3D immersive virtual world use in tertiary education is needed - it appears that knowledge and awareness of the potential is not yet being realised despite the recognition by Gartner and a move to the Slope of Enlightenment (Lowendahl,

2015). There are new hardware and software platforms being developed constantly that provide new and potentially more flexible environments in which educators can create even richer and more streamlined educational experiences. With the popularity of 3D virtual environment platforms for younger users, and more importantly, the growing recognition by their parents of the potential uses of 3D virtual environments, the future should see growing numbers of tertiary students who have literally grown up using virtual worlds of one kind or another. As existing platforms are refined and new ones developed based on the experience of developing and using existing platforms, it will become easier and easier for non-expert educators to develop the kinds of environments and activities suitable for their specific teaching needs. The reputation of virtual worlds in general appears to be improving over time as a diverse range of platforms and uses are being developed that are attracting a more mainstream audience.

Despite the ups and downs of virtual worlds in education over the last few years, they continue to be used in a variety of ways across a range of disciplines and research into their use for a whole range of end purposes has continued unabated until now. The results of the survey indicate there are many changes in the ways in which members are now using virtual worlds for learning and teaching. Within the context of higher education, the use of virtual worlds is still a relatively new and emerging area and the results of the survey indicate a continually shifting and settling within pedagogical practices, institutional support, academic and student attitude, perceived effort versus result and the affordances of specific platforms. Virtual worlds are part of the technology in education continuum, however there remains an ongoing persistence and resilience by educators integrating virtual worlds in teaching practices, despite the challenges. In keeping with the NMC 2015 reported themes, members of the VWWG felt that development/reuse/repurpose of virtual environments in higher education are important, there are still significant challenges impeding technology adoption and have outlined key trends in accelerating technology adoption in higher education. Further data needs to be collected internationally to expand on and confirm these results.

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