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Emerging trends in serious games and virtual worlds

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The role of 'serious games' in modern culture is a recent phenomenon, and broadly arises out of the wider use of electronic gaming for leisure purposes and the increasing use of the internet to support large online communities. Serious games, as distinct from leisure games, provide users and players with opportunities to explore non-leisure applications using games and immersive world applications for education and training, as well as supporting business and medical uses (Michael and Chen, 2006). The term has been coined to create a separation between leisure and non-leisure games-based activities in order to take games as training or learning tools more seriously. The use of serious games, in this way, may engage under-served learners, liven up school and tertiary curricula or provide support for lifelong learners in new and innovative ways.

The emergence of virtual world applications such as Second Life and ActiveWorlds provides potential for supporting learning communities in new ways. Virtual world applications, like immersive serious games applications, offer the capacity for using three-dimensional spaces as new learning spaces. This can support seminar activities, streaming lectures, create cyber-campuses and help to support distributed and remotely located learner groups. This may add value to existing educational provision, as well as extending new provision of learning.

Serious games and virtual world applications offer great potential for learners to step inside the screen of their imagining with such possibilities as role-playing characters from history to re-enact events such as in the game mod (modification) of Neverwinter Nights, Revolution, which was modified by researchers at MIT in order to study the effectiveness of game-based learning with students of history. The idea was to help students to role-play social characters during the American Revolution to allow them to empathise with the people from that time. These formats can also be used to role-play researchers perhaps interviewing famous scientists long deceased, or as scientists undertaking experiments only possible in outer space (see Figure 1). In this latter example, students can use the tool developed by researchers at the University of Wisconsin-Madison to enact physics experiments that cannot be employed in the real lab. Learners could also become virtual tourists visiting museums a thousand miles away (de Freitas, 2006; Sandford *et al.*, 2006). In addition, these applications are supporting a whole host of social interactions providing scope for learners to meet with mentors and subject experts from around the world, undertake virtual work experience or form a distributed learning community to solve challenges and problems, play educational games and share and produce content.

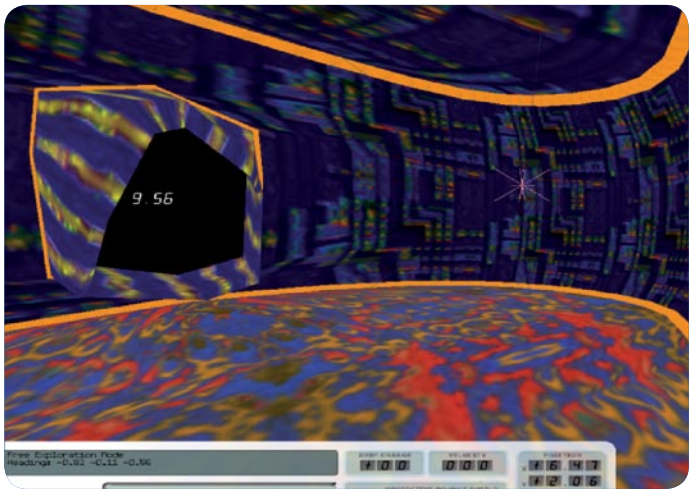

Figure 1: Supercharged used for physics students.

Reproduced by kind permission of Kurt Squire

Figure 2: Second Life.

Image reproduced by kind permission of Linden Labs UK.

Serious games and virtual worlds allow us the potential to:

- provide support for our learning communities
- broaden our networks of learners
- provide tools to support creative learning activity and experience design.

Part of the problem serious games set out to address is the gulf between learners' experiences with technology inside and outside formal education. For some at least, this provides a real opportunity to extend learning beyond the conventional boundaries to the widest number, providing scope for reorganising learning and designing learning activities and interactions to fit infinite possibilities. The challenge that faces us today is how we can best make use of these applications to support learning.

The area of 'serious games' and virtual world applications therefore encompasses a wide range of applications including the following:

- Serious games applications such as Flash- and Java- based animations, immersive 3D single- or multi-player games developed on proprietary platforms (see Figure 3). One example of the latter type of serious game application is the demonstrator being developed by TruSim (a division of Blitz Games). The demonstrator mocks up an explosion in a busy urban area, the learner role-plays the medic arriving at the scene of the explosion and is tasked with sorting through the casualties (Triage Sieve) in order of urgency. Increasingly, the crossover between leisure and non-leisure games is leading to more mainstream serious games such as Dr Kawashima's Brain Age and Big Brain Academy.
- Virtual world applications such as Second Life (see Figure 2) and ActiveWorlds, which are becoming popular with users – and more recently learners. Increasingly, universities are modelling their campuses into Second Life and onto other virtual world platforms. This virtual presence is allowing universities to reach new audiences and early adopters are utilising the capability to offer virtual seminars, streamed lectures and presentations. Virtual conferencing is a popular application with businesses, as well as recruitment, communications and marketing.

Figure 3: Triage Trainer.
Reproduced by kind permission of TruSim (A Division of Blitz Games)

Figure 4: Screen shot from emergency training session using Forterra. *Developed by Forterra Systems.*

One interesting example of how Second Life is being used is the use of Teen Second Life (for use by teenagers only) by the Open University. Here, students from the National Association for Gifted and Talented Youth (NAGTY) are taking lessons in virtual classrooms. The pilot developed under Schome, is a project aimed at developing new education systems in both real and virtual worlds. [http://schome.open.ac.uk/wikiworks/index.php/The_schome-NAGTY_Teen_Second_Life_Pilot]

- Serious games applications that can be created in construction toolkits whereby users can build and develop their own scenarios and worlds, such as Olive on the Forterra platform (based upon There.com). An interesting example of this trend is the emergency training sessions led by Stanford University and being piloted using Forterra (see Figure 4). Previously Stanford was closed down to facilitate emergency training sessions involving different organisations including medical and police forces. For the last two years training has been taking place in the virtual world and this has allowed distributed teams to role-play serious incidents using real people to play act victims and for the trainees to undertake lifelike training. This form of application has real potential for training with different organisations and allows us to mock up an infinite range of scenarios.

The capability of the 3D web extends and enriches the potential of the 2D web (including existing tools such as FaceBook, MySpace, Bebo and Habbo Hotel). The possibilities of the 3D web include the capability to integrate these and other 2D tools and toolkits, to support learner-generated content, to enable sharing of content and to allow us to visualise more clearly different scenarios of practice. However, increasingly the move towards the 3D web is also prompting the potential of convergent technologies and applications, such as mobile gaming, alternate reality gaming and augmented reality gaming, which are allowing for bridging between real and virtual spaces. This trend is having an impact upon design in the real as well as virtual worlds, with for example increasingly flexible designs of spaces being used in the real world to reflect greater possibilities and tie-ins with the virtual world experience.

The issue of definitions is one that has been and will continue to be hotly debated. Table 1 gives an idea of the different definitions and terms that are emerging daily in the field and can distract or put people off engaging with the area. An added complication is explaining the range of different kinds of applications available, and while it can be easy to show clips from demonstrators to illustrate this, those not familiar with the levels of fidelity and interaction can find it hard to imagine the possible uses.

Table 1: Definitions and terms of games

Term used	Related or synonymous terms	Descriptions & references
Educational games	Computer games, video games, serious games, game-based learning, instructional games	Games in general can be defined in surprisingly numerous ways, often changing the way games are used and perceived (Wittgenstein, 1958). Games are often defined as 'a series of choices' or as 'rule-based play'. For the purposes of this report, educational games for learning, like serious games, are defined as: applications using the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes and *experiences*.
Online games	Massively Multiplayer Online Role play Games (MMORPGs), Massively Multiplayer Online Games (MMOGs), persistent games, MMORTS (Massively multiplayer online real-time strategy), MMORPGs (Massively multiplayer online first-person shooter)	Online games are becoming more widely used since their emergence as multi-user dungeons / dimensions (MUDs) in the 1980s. Online games include simple text-based games as well as games that involve complex graphics and virtual worlds that are used by large numbers of players simultaneously. Broadband access to internet resources has made MMORPGs, MMORTS and MMOFPS very popular. In addition, the wider usage of Flash and Java has allowed gaming websites to use streaming video, audio, and introduce greater user interactivity.

Term used	Related or synonymous terms	Descriptions & references
Serious games	Educational games, video games, game-based learning, instructional games, sim games, gamesims	Michael and Chen (2006) give the following definition: 'A serious game is a game in which education (in its various forms) is the primary goal, rather than entertainment'. The following definition has been developed for the SG-ETS project: 'Serious games for learning are applications using the characteristics of video games to create educational and engaging learning experiences and deliver specified learning goals.' It is worth noting that Huizinga defined games as a free activity standing quite consciously outside 'ordinary life', as being 'not serious' (1980), and following this definition games cannot be serious. Callois similarly defined games as voluntary and therefore also conflicts with the notion of serious games (1961: 10-11). This gives a good indication of the kinds of contradictions found in comparisons of the available literature.
Simulations	Electronic simulations, virtual reality systems, training simulations or simulators	A computer simulation is a way of modelling a real-world situation on a computer. By altering variables, predictions about the behaviour of the system may be made. Simulations have traditionally been considered as types of games. But equally the earliest simulations were war games. The relationship between games and simulations has been close, and even when virtual reality systems were being pioneered, the power of immersive environments for learning was recognised. Also, simulations may be defined as non-linear exploratory environments (Aldrich, 2004, 2006).

Term used	Related or synonymous terms	Descriptions & references
Serious virtual worlds	Immersive worlds, 3D environments, virtual worlds, virtual environments, metaverses	The predecessors to the virtual world were the multi-user dungeons (MUDs) of the 80s, which had all the characteristics of the modern virtual worlds but were text-based. These media forms provided the foundations for the development of online communities supported in their daily activities by 3D and animated spaces providing a backdrop for the day-to-day activities that take place there. A serious virtual world is an environment where players and users can explore a 2D or 3D world, freely taking on the identity of an avatar (which represents the player in the virtual world), play games and participate with online communities. The earliest virtual world with avatars dates back to LucasFilms' Habitat in 1985 (Morningstar and Farmer, 1993). Over the last five years the use of virtual worlds for educational purposes has grown, including replicating universities, museums and art galleries, and science labs to creating fictional worlds for tutoring and mentoring (Prasolova-Førland *et al*., 2006). Most of the main open-ended virtual worlds such as Habbo Hotel, ActiveWorlds and Second Life use avatars, allow the creation of objects and construction of buildings. Some virtual world applications such as Guild Wars utilise a narrative and have quests, users can join guilds and fight monsters or collect objects.

The debate about definitions perhaps reaches its apotheosis in the arguments of Seymour Papert who debates the notion of 'edutainment' as neither as engaging as leisure games nor educational (1998). The hybrid form of edutainment like serious games does for some at least point to an anomaly: how can games be educational, how can they even be serious? In addition, many tutors and practitioners are keen to find out how effective game-based learning is and how they set about getting involved with game-based and virtual world learning activities.

Trends

The social and the immersive

The main change agents in the current environment can perhaps be posited as the wider uptake of the internet and globalisation. This has a social implication that is undeniably changing our social structures – including schools, colleges and universities – as well as substantial changes upon continuing professional development (CPD) and work-based learning.

The trend towards self-organising communities, flatter social hierarchies and the potential for distributed activities are having a reinforcing impact upon globalisation, making the world smaller and the interconnections and scope for social interactions greater. The drive towards greater potential for social collaboration, through social networks and often web-based self-organising communities, has led to sets of tools that are encouraging a significant trend towards mass user generated content (at present a quarter of all data is original) and IDC estimate that 70 per cent of content by 2010 will be user generated, on top of growing participation levels that were at 1 billion in 2006. The second result of the shifts of globalisation and the internet can be felt in the drive towards the 3D web, a new vision for information access and use centring upon visual rather than textual data, where the opportunity for user generation is key and where the integration of different media and tools is also significant.

Many talk of the 3D web and expect its use to grow significantly. In particular the trend amongst large multi-national companies such as IBM, PA Consulting and Reuters is towards exploring possibilities for collaboration and communication. Using 3D interfaces to a range of resources, materials and communications is a clear trend, with the emergence of 'mash-ups' where different programs are brought together, such as Google maps and databases with information about a local area. The trend is supported by the easier integration of programs using open standards and interoperability, and there is now a move towards interoperability standards for virtual worlds (see: http://www.news.com/Tech-titans-seek-virtual-world-interoperability/2100-1043_3-6213148.html). The role of distributed social networking is also becoming a clear trend with businesses notably taking up the new media technologies to support business applications and communications, as well as supporting applications from training to recruitment and providing a focus for interactions with customers.

Converging technologies, diverging applications

The greater scope of the convergence of 3D technologies, applications and tools with other media supports and extends this trend towards supporting evolving and self-organising communities. The rate of convergence of games technologies with other technologies is significant. For example, recent work

being undertaken is looking to build bridges between these different technologies. Alongside converging technologies is the trend of diverging applications from business solutions, to training, recruitment to work experience, sales and marketing to communications within and outside of the company and the range of emerging applications is diverse. This trend of converging technologies and diverging applications is unprecedented, and it is difficult to think of a media form that has led to such pervasive uses and applications as we have noted with the internet and game-based and virtual world applications.

Another strength of these applications is the capacity for integrating with different media and interactive resources, as well as integrating with available social software and collaborative tools such as live chat facilities, bulletin boards and shared resources, which means that these applications have real potential for supporting distributed communities in different geographical locations, or special interest groups, or mixed groups of learners (age, gender, nationality etc.). While for standard tutorial group structures this may appear less appealing, it does open up the option for learner groups studying out of normal hours of learning, or beyond the timeframe of the course, and open up real potential for learning outside the standard institutional framework.

The fast changing converging technologies offer a real challenge for IT support, particularly where a culture of a closed system has been adopted for security reasons. However, a balance between security and open access needs to be found. Institutions need to provide ways of supporting new emerging technologies and applications and this can be difficult in terms of staff training as well as needing a more flexible approach to IT support. The moves towards service-orientated architecture and interoperability may help to lessen some of these challenges and remote IT support is becoming more possible, but the role of the institution clearly needs to find new strategies for adapting to the proliferating 'worlds' particularly if it is to continue to remain relevant to those learners regularly engaged in exploratory spaces, using games applications and *au fait* with a range of different social software tools.

Sharing learner-generated content is becoming a way of life now, and the role of education is to take up these tools and help learners to become more adroit at using them, rather than ignoring or banning them. As practitioners this may indeed become a creative process rather than one to be feared. The new technologies offer the learners a chance to take a more empowered role in the learning interactions and activities, but also allow for deeper reflection upon learning, sharing learning resources and outputs and engaging under-served learners in new ways. In addition, the critical role of authoring content offers a diverse range of new approaches both to design and to learning. However, curricula and institutional structures may need to loosen up to adapt to the rapid change, and it will be important for tutors and tutor practitioners, as well as policy developers and senior managers, to make sure that the critical skills needed to

remain analytical are maintained at the centre of games and activity development and usage. The danger of using so many different communication channels simultaneously is that attention and focus may be difficult to hold, so work to enforce academic rigour, analysis and synthesis, as well as meta-reflection and higher order cognition, needs to be considered in learning design. The drive towards a more seamless learning experience more focused upon social interactions would benefit the learner through enriching learning, connecting with real experiences and reinforcing learning through social interactions.

Case study: Teen Second Life

The Open University undertook a study to evaluate the educational potential and pitfalls of Teen Second Life. The study aimed to find out more about how 14–19-years-olds use Second Life, and used 149 students from the National Association of Gifted and Talented Youth (NAGTY) as a sample. The study found that the level of engagement was comparable to other media. Of the 68 per cent of students visiting the island, 41 per cent spent more than an hour. Access was an issue particularly for some students. But those who could access the Second Life site Schome Park [http://www.schome.ac.uk] and participated with the wiki and forum developed a wide range of Second Life skills (such as moving around the environment, scripting and producing movies in-world and constructing objects), skills which were found to have transferable value. In particular the study highlighted communication, teamwork, leadership and creativity as the particular skills supported through the activities. Interestingly, those who used the wiki and forum showed higher levels of performance than those who just participated in Schome Park. Notably, students that found social aspects of life problematic at school found that Schome Park provided a more secure and safer environment within which to explore social relationships, leading to enhanced confidence and the development of social skills.

Quote from student:

'I think that what Schome is doing through breaking down the barriers between teachers and students making it hard to see where one stops and the other begins, is fantastic, because when everyone is on the learning curve together, it brings about less of a feeling of segregation and a greater feeling of equality, and this leads to trusting people more...'

(Twining, 2007).

Issues

Research overview

One of the issues with research in the field has been the lag between findings and innovative practice, and while this problem is not a new one it seems to be exacerbated in the current climate of fast convergence and rapid innovating practice. While much of the evidence for serious games, like e-learning in general shows 'no significant difference' when compared with face-to-face, blended modes of learning, when learners use multi-modes of learning, often accelerated learning and longer retention of information results.

The efficacy of games in studies, like e-learning in general, has been inconclusive, with 'no significant difference' being reported in some studies where face-to-face and game-based approaches are set head to head. However, as with other media-based learning, most evidence has pointed to blended approaches to learning being more effective than one or another, and this needs to be reflected in experiment design. Some data has come from surveys with users, and these studies have in general shown that some learners do not like using game-based approaches (de Freitas *et al*., 2006), but evidence from other studies indicates that this form of learning can change attitude (Hays, 2005) and that it can be engaging and motivating for learners (Garris *et al*., 2002; Mitchell and Savill-Smith, 2005), as well as being helpful for engaging under-served learners (de Freitas *et al*., 2006).

However, for certain user groups, in particular under-served, more visual and younger learners (see for example de Freitas *et al*., 2006), games have been found to have positive benefits. Moreover, when users are part of the design of the games (in particular using participatory design methods) the games may be substantially better taken up and are often more effective following as they do the learners' needs and requirements (see for example Dickey, 2005; de Freitas and Oliver, 2006). Despite some negative psychological studies finding a link with leisure game-play and addiction, the use of educational games and simulations on the whole does not show addictive behaviours, possibly because they are not as engaging as leisure games (de Freitas and Griffiths, in press).

While leisure games studies have shown that age, gender and cultural differences pervade, a recent study is revealing that there was no significant difference ($p<0.05$) between age, gender and culture regarding the use of specifically educational games. The finding confirms that serious and leisure games are still distinct categories, also indicating that educational games may be used with mixed age, gender and cultural groups to equal effect, as supported by other studies (de Freitas *et al*., 2006). The study which surveyed medics (nurses) also revealed that the 40+ group played significantly fewer games than the <30 and 30-39 age groups, and that the patterns of game-play between <30 and 30-39 were not as significantly different as would be expected.

An interesting confirmation of anecdotal evidence is emerging, which indicates the power of the format for engaging learners particularly in the under-40 age group, but studies have not yet confirmed the full power of educational games for older learners (preliminary findings as presented by de Freitas, 2007; Jarvis *et al*., 2007; data to be published).

Potential uses

Clearly, 'immersive world' applications have the potential to support communications between learners, to support problem-based learning opportunity and to support exploratory learning experiences (Saunders, 2007). However, much needs to be understood about how to best convert these spaces for learning purposes such as seminars, simulations, modelling, learning activities, networked learning experiences, cybercampuses and streamed lectures (Prasolova-Førland *et al*., 2006). While the spaces are excellent for bringing together the use of a range of different media (streamed video and audio, email, live chat, social network software, mind mapping software and others), questions remain as to how best to integrate these media to support the most enriched learning experiences.

Ohio State University is one example where Second Life is being used innovatively to support enriched learning experiences. The presence includes three units: OHIO Outreach, Ohio University and Ohio STEAM on the teen grid. The model centres upon serving traditional university students, distance and adult learners and high school students in a way that supports both live and asynchronous learning experiences. Using both futurist spaces and models of real-world buildings, the campus aims to engage learners, develop a unique identity for the university and to integrate a range of teaching tools such as voting and survey tools, learning objects and spaces for seminars and lectures. (See the video clip from Ohio State University campus at http://youtube.com/watch?v=aFuNFRie8wA)

The research has revealed that many of the early adopter groups have been in vocational training areas, which is not unexpected as games and immersive worlds applications have real potential with respect to experiential and exploratory learning models. In particular, the issue of learning transfer, which lies at the heart of the debate about the efficacy of game- and simulation-based approaches, relies upon a degree of fidelity to the real work experience, and here games technologies are making leaps and bounds. Cost has also been a factor in the pattern of uptake in the new sector, and areas with large numbers of students, or where training has life and death consequences (such as medical and military applications) have reflected this imperative. However, with the emergence of immersive world applications, such as Second Life and ActiveWorlds, this trend is changing and new areas of training involving cross-agency training, emergency training and professional training across different areas are becoming possible. The fact that new areas of training are now

possible through these new means implies a greater need to consider the pedagogic underpinning of training in virtual worlds, and frameworks and models (such as Four Dimensional Framework and Becta's Quality Principles for Digital Learning Resources) are slowly emerging to help us to design, develop, select, use and evaluate serious games and virtual worlds applications.

One example of medical use of serious games demonstrators is the Pulse!! project – The Virtual Clinical Learning Lab. This is a virtual training environment designed to support a range of the training needs required by nurses and medical professionals. The US Department of the Navy's Office of Naval Research is funding the immersive virtual learning space, being developed by BreakAway Ltd, for the Texas A and M University-Corpus Christi. Virtual patients, using artificial intelligence (AI) will respond in lifelike ways to environmental changes and medical techniques and skills used by the trainees. The system may be used by new trainees or for established professionals to update training. (Johnston, 2007; see also www.sp.tarnucc.edu/pulse/index.shtml).

Alongside CPD and training, and cross-agency distributed learning opportunities, scope for learning in colleges and universities using seminars in SL, sharing resources, cross-disciplinary teaching, team teaching and wider use of mentoring are emerging. Aspects that may well help to enrich the learner's experience and allow them scope to become more active in their learning, through developing their own scenarios of practice, their own content and their own perspectives upon reflection and meta-reflection. The scope for virtual work experience, for example, would allow learners to create better links between their studies and their chosen path in life.

In the field of science education a number of exciting tools and games are emerging to bring to life experiments that in some cases could not be undertaken in the lab. The scope for games and immersive world applications to reach under-served learners, and learners with no previous interest in science education, could unlock a new enthusiasm for subject areas where traditionally few learners have participated (de Freitas *et al*., 2006). The tools also allow for cross-disciplinary teaching, which could also allow tutors to engage learners in weaker areas.

An interesting example is SciLands, the science and technology region of Second Life. The region is well worth a visit and includes many highlights including the International Spaceflight Museum and the recently launched Nanotechnology Island. Resources available to this community include, shared resources for those in formal and informal science education and an extended network of specialists and organisations. Imperial College, London and the National Physical Laboratory have developed Second Health, a 3D vision that provides a vision of health of the future (see the video link to Second Health: Polyclinic Tour, at http://secondhealth.wordpress.com/movies).

The potential uses of games, simulations and virtual worlds are many and varied and it will be interesting to see how these are exploited within academic research and teaching circles over the next five years. Will the emphasis upon collaborative learning, for example, lead to new teaching and learning models, will learners more generally become the 'authors' of their own learning materials? Will tutors become the choreographers of learning experiences through designing activities and scenarios, and through mentoring?

Impact upon learning

The use and adoption of virtual spaces has an implication upon where, what and how we learn. This change is already being felt, as we design our physical spaces to reflect the need for multi-usage of space, and as learning itself becomes less about conveying information and more about designing experiences and activities. The emphasis upon more seamless learning experiences that may cross the boundaries of real, virtual or imagined spaces, has challenges for us of course, as managers, as tutors, as learners and as designers or choreographers of our own learning trails or pathways. In the end, it would seem as though learning becomes less about the ability to reproduce standardised components of learning, and more about allowing individuals to inform and design their own learning interactions and transactions.

This possibly more empowered model of learning not only challenges us but also, and centrally, our institutions and organisations, favouring more decentralised structures with more dynamic and adaptable structures and self-organising communities emerging to support change, not like the current personalising learning agenda.

The impact of games and immersive world applications upon our learning therefore may be substantial, and for this reason needs to be explored by managers, researchers, tutor practitioners and learners. The need to produce guidelines, supports and communities to help us both understand and research new learning experiences is critical to the ongoing development of our online and offline communities. However, we need to adopt the same critical approaches that we apply to the real world in order to allow us to reflect upon and become part of the design mechanisms emerging to support the wide uses and applications of games and immersive worlds.

Collaborative learning is definitely not a new prospect for educators and learners, as most learning takes place collaboratively in groups as part of social interactions. However, the major paradigmatic changes occurring with globalisation and the use of the internet are making our worlds smaller and allowing us to reconsider how we learn, where we learn and what we learn. Perhaps what we are really talking about is the need to adapt to a changing vision for education based rather upon more immersive learning experiences and social interactions.

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