
Editorial

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Biographical notes: Carlos Delgado Kloos received his PhD in Computer Science from the Technische Universität München and his PhD in Telecommunications Engineering from the Universidad Politécnica de Madrid. He is currently a Full Professor of Telematics Engineering at the Universidad Carlos III de Madrid; the Director of the Erasmus Mundus Master's Programme on 'Network and eBusiness Centred Computing'; the Director of the online Master Máster online en 'Gestión y Producción en E-learning'; the Director of the Nokia Chair at his university and the Coordinator of the eMadrid network. Additionally, he is an Associate Vice-Chancellor of International Relations. His main research interest focuses on technology-enhanced learning.

Daniel Livingstone lectures Computer Game Technology at the University of the West of Scotland, and is an active researcher in the educational applications of multi-user virtual environments. He was a co-founder of the open-source SLOODLE project – the world's first project attempting to formally integrate multi-user virtual environments with web-based virtual learning environments, bringing together Second Life (and now Opensim) with the open source Moodle web-based learning environment. His other research interests also include artificial intelligence in games and the use of handheld devices for game based learning.

Game-based learning, 3D simulations, and the educational use of virtual worlds have all seen significant growth over recent years, and are now in widespread use across many educational sectors and disciplines. In part this spread merely reflects the increasing ubiquity of computer games themselves, but also the increasing awareness that 3D virtual environments can provide engaging and immersive learning experiences. While the field is maturing, technological developments continue to create new opportunities for innovative and creative ways to apply 3D to learning and education.

This special issue recognises both the maturation of 3D learning and the emergence of new opportunities. The five papers included in this issue explore 3D learning from different perspectives – reflecting on the field as a whole or focusing on specific technologies or discipline areas.

Across consoles, personal computers, mobile phones and social networks, a wide variety of computer games and simulations are available to suit an increasingly diverse and broad range of tastes and interests. This diversity of games and of gamers challenges some of the early assumptions and assertions about games based learning, as the paper by Hollins argues. Where once the term 'gamer' implied a young male with an interest in fast action 'twitch speed' games, today's gamers are perhaps as likely to be female as male, to be pre-teen or middle aged and to be playing a slow-paced web game on their social network instead of indulging on a virtual rampage on their console. As the field of game-based learning matures, researchers and practitioners will need to be increasingly aware of and responsive to this diversity.

Studying one particular type of 3D learning environment – the 3D virtual world or multi-user virtual environments (MUVE), Wan, Reddy and Longman consider how such learning environments can promote student engagement. On the basis of five case studies across a range of disciplines, the authors highlight the importance of narratives in these environments and how these can foster communities of practice to improve the learning experience.

Yet, some discipline and application areas appear to be particularly amenable to the use of 3D virtual worlds. One of them is the recreation of the past; another is for learning foreign languages. The paper by Pantano investigates the use of 3D environments for learning about the cultural heritage, relating different online consumer types and patterns of consumption to the learning experiences available online. Dominguez-Noriega, Agudo, Ferreira, and Rico focus on the learning of foreign languages, again using *Second Life* as a base platform – but describing a system which extends this with a computer controlled AI guide and an integrated web-based learning management system.

Recently, augmented reality (AR) techniques have gained significant growth in interest. This has been driven by mobile devices that by means of camera and display and a variety of sensors on the one hand and communication and computation capabilities on the other, allow the superimposition of multimedia content over images captured by camera. Luckin and Fraser evaluate the impact of an AR learning game on learning, and ask how far the current results go in matching the medium's potential.

Between them, these five papers represent an overview of some very different ways 3D environments can be used for learning – from 3D enhanced websites to immersive virtual worlds, to AR. But even with this breadth of coverage, there remain many current and open research questions and directions which can be identified from the work presented here. Pantano's exploration of the different types of consumers of learning materials, and Hollins' arguments on the need for stronger recognition of the great variety in both games and gamers, both indicate that we need to improve our understanding of our learners' varied needs to be able to create 3D learning experiences that meet those needs. This will require identifying both specific and general requirements – those specific to particular subject disciplines or types of game, and principles that cross discipline and/or genre. Wan, Reddy and Longman's identification of the importance of narrative in 3D learning environments can be considered indicative of the latter.

Research will also have to consider, as Luckin and Stanton do, the mode of use of 3D learning environments: whether a supplementary exercise in class; a self-contained study exercise for personal exploration at home; or some mixed or other use. Again, there remain gaps in our understanding of how games and simulations might be optimised for particular modes of use, or for creation as flexible learning activities that can be used in a rich variety of settings.

Artificial intelligence guides and database tools that are able to map personal profiles of users' knowledge, understanding and learning are likely to prove increasingly important in the future as developers try to support ever greater numbers of learners and learning needs. More work on integrating different learning platforms, as discussed by Domínguez-Noriega et al., will form an important foundation layer for this work. And beyond the purely technological, there remains an urgent need to better understand how learners and teachers will be able to integrate these new technologies and games into existing teaching and learning practice – or whether we will need to see substantial reform of educational practice before these technologies can reach their full potential.

Thanks to the authors of all of the papers submitted to the special issue, the five best of which are included here. Ambjörn Naeve, editor-in-chief, and Fridolin Wild, managing editor, are also thanked for their considerable help during the preparation of this issue.