

VIRTUAL REALITY FOR TEACHING & LEARNING IN GEOGRAPHY: PRACTITIONERS' REFLECTIONS

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ABSTRACT

This paper outlines the technical specification of our SPLINT (Spatial Literacy in Teaching and Learning) virtual reality (VR) facilities. We discuss how the theatre has been used for learning and teaching, providing snapshots of a range of applications and contexts in which students are engaging with the facility. While evaluation of the immersive 3D theatre in terms of improving learning performance is underway, we acknowledge that collating suitable data sets for quantitative analysis will require presentation of the VR tools to a number of student cohorts. At this time, we draw together a number of questions and reflections on our experiences to date based on staff and student feedback and focus groups.

A number of interesting points for further investigation have arisen, relating for example to: How we best blend VR tools with more traditional approaches to teaching and learning in the wider curriculum; How we foster a participatory approach to model building such that the time consuming nature of implementing real-time 3D visualisations is mitigated; The need to prioritise the design of re-usable VR learning objects; The relationship between interactivity and learning and the apparent perception of the VR experience as an active learning opportunity. What is clear from our findings to date is that the sense of theatre and active engagement afforded by the immersive environment and face-to-face group participation make our particular approach distinct as compared with other 3D virtual learning environments, such as for example Second Life; the approach taken here also affords richer scope for both technical *and* application learning in Geography.

Key words: Virtual reality, 3D visualisation, immersion

INTRODUCTION

Recently, via HEFCE funding in the form of the Spatial Literacy in Teaching & Learning (SPLINT) CETL, we have been fortunate to acquire a range of virtual reality hardware and software resources within the Department of Geography at Leicester. While many larger Universities have an immersive visualisation environment as a central or computing based resource, the location of such a facility within a Geography Department, to be used both for learning and teaching and research purposes, is highly unusual in a UK context beyond the SPLINT consortium. This paper reflects on two years work developing and integrating these facilities within the curriculum, looking at both the affordances and difficulties we have encountered over the period.

Firstly, to provide some technical background, we outline the equipment and software available for this work. Secondly, the paper looks at teaching and learning developments that the equipment has afforded. Important to the context of this work is that the virtual reality resources are situated in a context where IT, in the form of GIS, forms an important research and teaching focus of the Department. Uses of the theatre for teaching and learning can thus be divided into two streams: The VR theatre as an environment for teaching and learning, and technical considerations of visualisation in digital geographies. Finally, we weigh up our experiences in development virtual reality environments for teaching and learning, drawing on both staff and student feedback and reflection.

THE SPLINT FACILITIES

The principal teaching and learning resource supporting the teaching and learning developments reported here is a small virtual reality theatre seating 12 people (Figure 1), installed at Leicester in 2006.

The technical specification for the VR hardware is shown in Figure 2. This VR laboratory is small, providing an intimate and relatively immersive stereo visual experience. Additionally, in addition to the six-projector stereo system, a small shuttle unit allows non-stereo visualisations from applications such as Google Earth and ArcGIS to be projected across the wide screen.



Figure 1. SPLINT Virtual Reality theatre, Department of Geography, University of Leicester

SPLINT VR Theatre, Hardware Specification

Theatre overview: *A state of the art immersive theatre that is capable of displaying passive stereo at an approximate resolution of 3200 horizontally and 1024 vertically with a 160 degrees Field of View (FOV) using 6 Image Generators (IG).*

Image generation: *Each IG houses two 2GHz AMD Opteron™ Processors, with 2GB of RAM and a 512MB NVIDIA Quadro FX4500 graphics card, and drives one projector. The graphics card comes with the G-Sync option, which delivers hardware frame locking and GenLocking functionality in order to provide advanced multi-system visualization and multi-device film and video environments.*

Projection: *6 3D-Perception SX30i projectors, each with a resolution of 1280 x 1024 and a 2000 ANSI lumens output. The projection is composed using 3 projector pairs, with each pair projecting a 68° FOV channel and each projector projecting either a right or left eye image. With an approximate overlap of 20%, a total of 160 degree FOV and an approximate combined resolution of 3200 x 1024 is achieved. Via a serial chain, the projectors can be remotely controlled from the Host computer.*

Contractor: [Antycip](#)

Figure 2. Virtual Reality theatre – Technical specification

Class sizes frequently exceed the numbers the theatre can accommodate. Moreover, the fixed nature of the theatre means that there is a danger that our SPLINT work could become too inwardly focused. With these points in mind, we have also purchased a portable passive stereo projector rig and screen that can be set up in larger lecture halls on or off campus. Our portable VR system is currently powered by a high performance laptop. This second system allows us the flexibility to experiment with alternative software in addition to its compatibility with teaching applications run in the main theatre via the installation of similar software. Importantly, any PC software that enables stereo output may run in stereo using such a rig following careful setting of the standard display settings.

VR related software installed in the visualisation and analysis suite adjoining the theatre includes Presagis Vega Prime to manage the virtual environments plus Creator for urban and/or abstract modelling together with Bionatics RealNaT and

Blueberry are assisting us with the representation of realistic natural landscapes. For those coming to our particular VR set-up with existing models, Okino Polytrans software provides a means of converting a range of pre-existing existing 3D models to our particular VR framework. This relatively high cost software, in Geography terms, is complemented by a range of alternative

software such as Google Earth Pro, SketchUpPro, Adobe Premiere, 3D Max and a variety of games engines.

TEACHING AND LEARNING INCORPORATING VIRTUAL REALITY

3D models as a means of enhancing subject-based understandings related to inherently 3d concepts and/or complex space-time phenomena

While there are many examples of immersive VR being used in medical education, this is less evidence within the environmental literature. The 3D visualisation literature suggests considerable untapped potential for the use of VR in teaching and learning both in geography related subjects and across a wide range of disciplines; chemical models, geological complexities, magnetic force fields, anatomical structures and reconstructed archaeological monuments are just a small number of possibilities.

Further, where examples are presented, their effect on learning processes and the place in which they best sit as part of an overall blended pedagogic model is rarely considered. Part of SPLINT's VR work at Leicester aims to address these gaps in the pedagogic literature in addition to seeking effective ways of re-purposing materials and models such that the use of VR for teaching and learning purposes becomes less resource intensive. A range of 3D visualisations, presented within the VR theatre or via our portable stereo rig, are being developed and evaluated for their learning effectiveness. Learning and teaching tools are currently in the progress or either development or evaluation include the following:

The use of stereo VR to aid student understandings of locational error in GPS of different types and at varied locations: Leicester Campus model

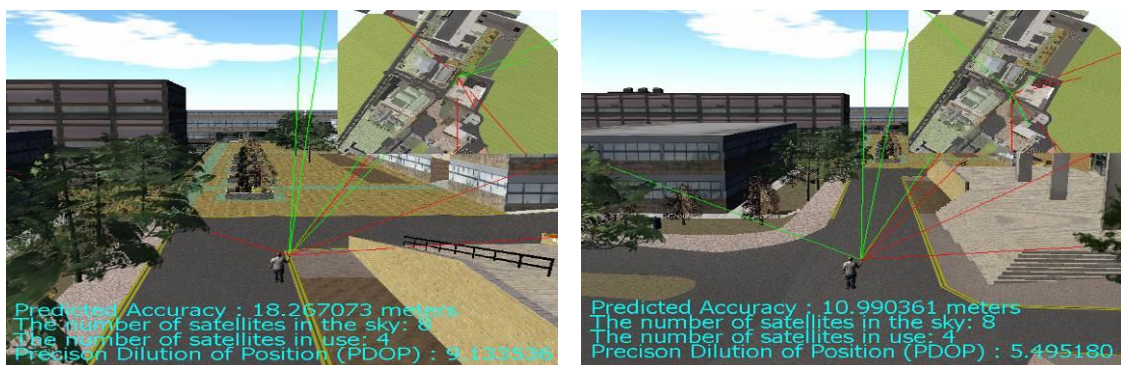


Figure 3. Global Positioning System (GPS) “mission tool”

This application (Figure 3) presents a real-time simulation of Global Positioning Systems (GPS) satellite geometry is carried out in a virtual environment of the University campus. The number of satellites visible to the receiver is modelled in real time as a user walks through the university campus. In the mean time, Position Dilution of Precision (PDOP) is displayed on the screen as well as the satellite geometry being visualised in both 3D and aerial views (Li, Jarvis & Brunsdon 2008).

The use of 3d to visualise mathematical functions such as those used in interpolation, and to view the effects arising as a result of particular method or parameter configurations

Our second GIScience-related example is a VR visualisation tool with the aim of improving our communication of inherently spatial processes to students finding difficulties in mapping mathematical representations of surfaces and parameter options, in the setting of an interactive and immersive group discussion within our VR theatre (Li, Jarvis & Brunsdon 2008). In particular, this example focuses on comparisons between algorithms used for interpolation and the effect of their parameters on the resultant surfaces (Figure 4).

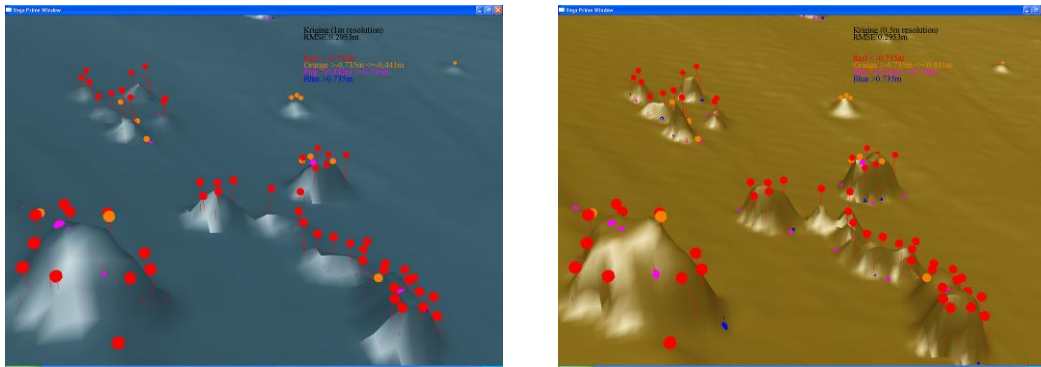


Figure 4. Interpolation tool

The role of immersive 3d landscape models in providing students with an apriori sense of place prior to field work overseas: Almeria, SE Spain

The concept of the virtual field course is now well developed, and exists in a variety of forms with different goals according to task. In has been our experience that students often take a while to become accustomed to a new environment and gain a sense of orientation, sometimes slowing process based learning. In this case, among other strategies, we are investigating the use of an immersive 3d theatre environment to familiarise students with a field area in SE Spain (Figure 5).

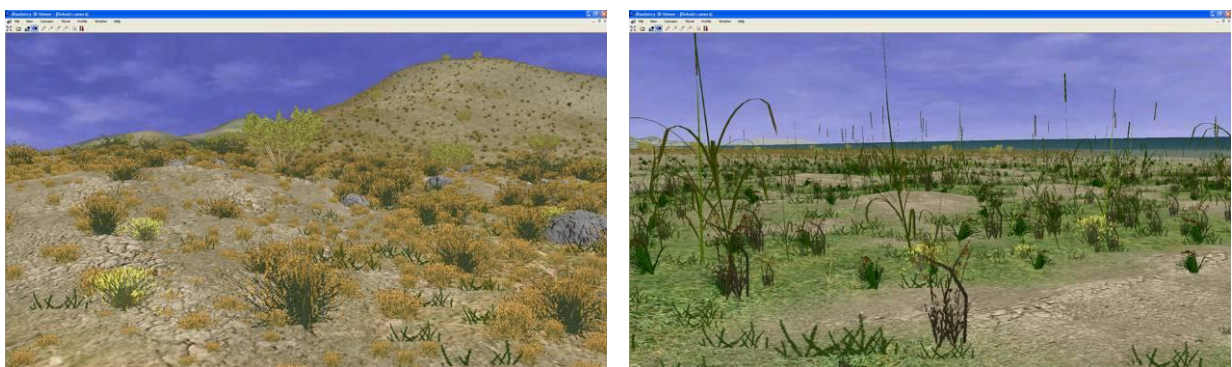


Figure 5. Almeria fieldcourse familiarisation tool

Neo-geographies in teaching and learning: Viewing field collections of GPS photo-tracks in Google Earth

Our VR theatre is in the main used for real-time stereo viewing of 3d modelled environments (artificial or pseudo-realistic, natural or man-made) but is also convertible to a wii-controlled wide screen environment for viewing Google Earth or similar environments. Students are able to geo-tag photographs taken on led tours or independent group work, as a means of collating and reviewing the evidence they have collated for project work. Similarly to the Almeria example above, our intention is also to allow students to better place their work in geographical context in order for them to familiarise themselves rapidly with a new environment and thus make best use of time in the field. This approach has been trialled as part of 2nd year human geography fieldwork to New York (Figure 6, overleaf).

Technical considerations of visualisation in digital geographies

New opportunities relating to virtual reality methods and modelling are ongoing as part of our visualisation module within the department's MSc in GIS degree programme. Similarly, but at a different level, undergraduate students are using the theatre as a learning space within which to consider the role and place of digital visualisations and issues such as realism, interfaces, complexity and the public communication of science.



Figure 6. New York review using Google Earth with wii remote interaction

Within SPLINT, our aim is to encourage students themselves to develop 3D VR representations; VR laboratories elsewhere can often be seen as the territory of research staff only. Two former BSc students, who graduated in July 2006, received student bursaries to develop VR projects this summer, while another 3rd year BSc student recently undertook an independent dissertation project visualising vegetation and topography relationships in the Tabernas badlands of SE Spain (Millman 2007). A variety of MSc dissertation projects have also been completed, with others underway. New opportunities relating to virtual reality methods and modelling now forms a component of our visualisation module within the department's MSc in GIS degree programme. The bank of student-constructed materials also provides materials for illustrating a variety of technical issues and technical/application developments to future students (e.g. Chapman 2007).

REFLECTIONS

Important to the context of this work is that the virtual reality resources are situated in a context where IT, in the form of GIS, forms an important research and teaching focus of the Department. This allows us considerable leverage in terms of software and expertise, and affords a dual teaching use for the VR theatre from both technical and application perspectives. In these matters, we are fortunate, and not all institutions will have such resources to hand. However, many Universities have some component of these resources on campus, and may be interested in liaising with geographers. Further, while a static immersive VR theatre requires considerable financial outlay, the price of a smaller portable screen and dual projector system is likely to fall within the reach of many. Additionally, the cost of immersive headsets and real-time visualisation environments, for example in the form of games consoles and their associated interactive devices, is decreasing such that gaining access for students to such facilities may prove un-troublesome in the future.

Evaluating the teaching and learning benefits of the materials collated to date is an important issue, but one that will take further excursions of our VR tools to larger numbers of students and evaluation research subjects before a statistically sound body of quantitative data may be analysed in addition to qualitative perspectives gathered via interviews and focus groups. Emergent questions and further work are being carried out, *inter alia*, on the following points:

- Stereo is known to distort distance (and potentially height) perception. Further work is underway to evaluate this effect in small scale rural and urban landscapes, along with interventions to allow students to measure distances such that issues of geographical scale important for geographical teaching are managed appropriately.
- It is known that people get lost relatively easily in virtual environments of many types. Work is underway on a variety of interfacing tools to assist students with wayfinding and navigation (Roussell *et al.* 2008), and to ensure that the learning opportunities potentially provided by VR teaching tools are not gender biased in this regard.

- VR applications should conjure up a sense of place, but high levels of detail and realism do not in general appear to be critical to the response of students to particular applications, regardless of whether they are familiar with high quality games graphics.
- What makes a good VR teaching intervention? Evidence to date supports the view that inherently 3D phenomena and hidden phenomena present particularly strong opportunities but, perhaps surprisingly, does not highlight student interactivity as an essential component in the decision making process (Jarvis 2008, Jarvis & Priestnall 2008). Further, the theatre environment provides an intimate, immersive learning space that allows us to capture student engagement and debate in new ways.
- Real-time manoeuvrability of a VR visualisation plus stereo immersion appears to give students a sense of 'hands-on' active learning even when a staff member is conducting the VR session. Students enjoy an opportunity to interact with the visualisations as a matter of technical curiosity and engagement, and are able to interact with the tutor to visit or revisit different aspects of a visualisation as a matter of course, but do not consider direct interaction critical to the subject-related learning.
- How should we best integrate the use of VR with other more traditional teaching approaches to lever maximum benefits to learning? (Jarvis et al. 2008; Dickie & Jarvis 2008)
- What makes a good VR model bases, from the perspective that these are time consuming to build and need to be designed with a view to maximising their potential in a number of learning arenas and at a variety of levels?
- Can a participatory approach to model building and development, involving both staff and students, realistically assist in the development of re-usable applications in addition to providing learning opportunities?

In sum, while initial qualitative evidence suggests that the materials are being well received by students as a supplementary teaching approach, the answers to many of these questions regarding the use of this learning space remain in progress. What is clear is that the sense of theatre and active engagement afforded by the immersive environment and group participation make this particular approach distinct as compared with other 3D virtual learning environments, such as for example Second Life; the approach taken here also affords richer scope for both technical *and* application learning. While set-up software and hardware costs for this particular facility were high, the approaches and pedagogies adopted should afford benefits when looking to lower cost future options involving games technologies.

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