STEM education with Unity 3D

Conference or Workshop Item

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STEM Education with Unity 3D

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Projects in Second Life

• socialisation
• team working in distributed teams
• design of 3D learning spaces
• navigation and wayfinding in 3D learning spaces
Institutional perspective

- software not owned by us
- control
- availability
- not perceived for education alone

3D virtual environment and a Field trip

- scope to demonstrate interactivity
- realism and high degree of fidelity
- visual and spatial experience not constrained by a ‘flat’ 2D user interface, sense of being there
- helps internalise the sense of exploration
Field trips in our institution

- real field trips two or three times a year (tutor-led)
- DVD to facilitate reflection and activities
- DVD also helpful for students who are unable to go for real field trips

Lake District in the UK

- Skiddaw field area
- 6 sites
- Skiddaw group of rocks: sandstone, slates, granite
- Geological significance
  - how *metamorphism* varies in the Skiddaw group sedimentary rocks due to the intrusion of the Skiddaw granite
  - how the Skiddaw group rocks *deformed* during the mountain-building event
Realism: Virtual Geology Field trip

• Realism
  – design of the environment or landscape
    – LIDaR data
    – Photogrammetry data
    – 3D modeling to weave it together
  – learning activities (similar to a real field trip)
    – choosing the equipment, learning to use the compass, sketching rocks

Video Part 1 (what to look for?)

• audio and textual guidance (tutor-led)
  – introduction
  – Geology of the area
  – instructions for learning activities
• choice of avatars
• choosing equipment for the field trip
• list of learning activities
• using the compass, sketch points and sketching
• http://www.youtube.com/watch?v=5_h4Nl3AvCY
Realism: Virtual Geology Fieldtrip

- Realism: multi-user or multi-avatar environment
  - tutor-led
  - group exploration
  - whose online and where?
  - text chat
  - settings to control the multi-user functionality

Non-realism: 3D Virtual Geology Field Trip

- Non-realism (things you can’t do in a real field trip)
  - microscopic views of rocks within the environment
  - draping maps on the landscape
  - cutaways into the mountainside to see the geology underneath
Video Part 2 (what to look for?)

- student investigates grain composition of one rock
- overlaying maps on the landscape
  - ordnance survey map
  - Geology map
- cross-section of the mountains
  - showing the rocks (geology) underneath
- different views in each of the contexts
  - overhead, North-East, North-West, etc.
- [http://www.youtube.com/watch?v=MOdu5jQukUk](http://www.youtube.com/watch?v=MOdu5jQukUk)

Opportunities for students and educators

- practice/training for real life field trips
- reflect on your experiences of real field trips
- fly across the landscape
- additional field trip to a real field trip
- could replace a real field trip if resources are limited
Limitations: student learning and experiences

- risk awareness skills
- challenges of being outdoors
- challenges posed by the weather
- challenges of using the equipment in real life
- bonding with other students

Challenges of 3D virtual field trips

- costs involved in design, development and evaluation
- multi-skilled team and specialist developers are required
- student training
- overcoming the (negative) perceptions that people have about virtual field trips
- how best to communicate that virtual field trips are not being proposed to replace real field trips
Why Unity

Pros:
- Browser based deployment (with plug-in)
- Complete control over client and server (cf Second Life/OpenSim)
- Support for large areas and high detail meshes
- Allows 2D and 3D learning segments
- Fully robust and stable
- iPad deployment

Cons:
- No in-built avatar capability
- No in-built multi-user capability
- You need to build EVERYTHING

Wide Area Model

- 10km x 10km = 1600 sims!
- Digital Elevation Model derived from airborne radar database
- Terrain imagery derived from aerial survey, c.1-5 m detail
- Cleaned in Blender/3D Studio Max and imported into Unity
- Walk, fly or teleport navigation (with compass & minimap)
## Site Models

- 6 sites, typically 50m x 50m, c.2-10 cm detail
- Photogrammetry derived mesh and texture imagery
- Cleaned in Blender/3D Studio Max and imported into Unity
- 6 individual rocks, again photogrammetry scanned to c.1-5 mm detail
- Augment with in-built Unity terrain and flora
- 1 rock has more data than 1 site, 1 site has more data than whole 100 sq km model. 500MB downloaded

## Avatars

- No standard avatar, animation or clothing model (Unity4 now has standard animations)
- Third party avatars have different skeletons, need different animations,
- No common look & feel (and often very “gamey”) 
- Clothes typically integral to the mesh, so SL style wardrobe/skin/hair layers
Multi-User

- No in-built functionality in Unity3D, wrote it all ourselves
- Played with Jibe but settled on PhotonServer as it gave us finer control and was more generic
- Cloud or locally hosted reflection server to manage multi-user comms
- “on-line/where is” list, chat, and “visibility fader”
- Hybrid mode – you can see other users, they can see you, but you don’t see their changes to the environment – ideal for fieldwork type activities (eg picking up rocks, changing map layers etc)

Future options to create a “tutor” mode with god powers over other avatars, and instances/shards so each class can have own version of the environments

iPad version

- Demonstration only at moment – only one site
- No keyboard/mouse so slightly different UI
- Virtual joystick for avatar movement
- Very limited memory given size of meshes and textures
- Feels far more tactile/engaging, and iPad screen size adequate
Summary

What we've liked:
- Having complete control of the environment
- Building a multi-user environment with only the functionality you need for an educational task
- Running through a browser and on an iPad
- The site visit (see right!)
- Working with the OU team!

What we've not liked (so much)
- Having to build EVERYTHING
- No standard avatars and animation
- Matching 3 different terrain modelling techniques