STEM education with Unity 3D

Conference or Workshop Item

How to cite:

For guidance on citations see FAQs.

© 2013 Faculty of Mathematics, Computing and Technology, The Open University, UK; 2013 Faculty of Science, The Open University, UK

Version: Version of Record

Link(s) to article on publisher’s website:

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online’s data policy on reuse of materials please consult the policies page.

oro.open.ac.uk
STEM Education with Unity 3D

Dr Shailey Minocha and David Burden
The Open University, UK and Daden Limited

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
<table>
<thead>
<tr>
<th><strong>Realism: Virtual Geology Field trip</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Realism</td>
</tr>
<tr>
<td>– design of the environment or landscape</td>
</tr>
<tr>
<td>– LIDaR data</td>
</tr>
<tr>
<td>– Photogrammetry data</td>
</tr>
<tr>
<td>– 3D modeling to weave it together</td>
</tr>
<tr>
<td>– learning activities (similar to a real field trip)</td>
</tr>
<tr>
<td>– choosing the equipment, learning to use the compass, sketching rocks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Video Part 1 (what to look for?)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• audio and textual guidance (tutor-led)</td>
</tr>
<tr>
<td>– introduction</td>
</tr>
<tr>
<td>– Geology of the area</td>
</tr>
<tr>
<td>– instructions for learning activities</td>
</tr>
<tr>
<td>• choice of avatars</td>
</tr>
<tr>
<td>• choosing equipment for the field trip</td>
</tr>
<tr>
<td>• list of learning activities</td>
</tr>
<tr>
<td>• using the compass, sketch points and sketching</td>
</tr>
<tr>
<td>• <a href="http://www.youtube.com/watch?v=5_h4NI3AvCY">http://www.youtube.com/watch?v=5_h4NI3AvCY</a></td>
</tr>
</tbody>
</table>
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

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 download

### 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 (e.g., 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
<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>What we've liked:</td>
</tr>
<tr>
<td>– Having complete control of the environment</td>
</tr>
<tr>
<td>– Building a multi-user environment with only the functionality you need for an educational task</td>
</tr>
<tr>
<td>– Running through a browser and on an iPad</td>
</tr>
<tr>
<td>– The site visit (see right!)</td>
</tr>
<tr>
<td>– Working with the OU team!</td>
</tr>
<tr>
<td>What we've not liked (so much)</td>
</tr>
<tr>
<td>– Having to build EVERYTHING</td>
</tr>
<tr>
<td>– No standard avatars and animation</td>
</tr>
<tr>
<td>– Matching 3 different terrain modelling techniques</td>
</tr>
</tbody>
</table>