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Developing a 3D virtual geology field trip in Unity 3D: reflection of our experiences

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The Open University

Developing a 3D virtual Geology field trip in Unity 3D: reflections of our experiences

Dr Shailey Minocha

The Open Science Laboratory

<http://www.open.ac.uk/researchprojects/open-science/>



My name is Shailey and I work at The Open University in the UK. This is my LinkedIn Profile: <http://www.linkedin.com/in/shaileyminocha>

It is a real honour to be here and in this magnificent auditorium.

The Open University is a world leader in modern distance education. The Open University or OU is the largest academic institution in the UK, in terms of student numbers. It is over 240, 000 students. *Since the OU's launch in 1969 almost 1.8 million people worldwide have achieved their learning goals by studying with us.*

Our students come from the widest possible range of backgrounds. We have students who are in their teens, including some Year 12 and 13 school students who are studying OU courses alongside their school education. We have students in their 90s - and all ages in between. We are the largest provider of higher education for people with disabilities. More than 17,000 people with disabilities studied with us in 2011/12.

We provide a rich mix of teaching materials to our students: books, DVDs, CDs – and each module has a space on the Virtual Learning Environment (VLE) where discussion forums are set up and tools such as blogs and wikis are used for reflection and online collaborations.

In Science modules, we provide students with a number of interactive online experiments – such as using a virtual microscope to view rocks, to carrying out a flame test, and to remotely controlling a telescope in an astronomical observatory.



In 2012, we received funding from the Wolfson Foundation to set up an Open Science Laboratory that would bring together a number of online science experiments.

The Foundation also wanted that we should make at least 20% of the resources free and open access.

This is the URL that gives the background details of the Lab:

<http://www.open.ac.uk/researchprojects/open-science/>

This is the URL of the Open Science Laboratory:

<https://learn5.open.ac.uk/course/view.php?id=2&page=1>

After an initial registration which requires an email address and password, you will have access to many interactive science experiments that are targeted to schools and to higher education students.

The 3D virtual geology field trip that we developed in Unity 3D is one of the activities in this Open Science Lab:

https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=skiddaw_1

3D 'social' virtual worlds



- avatar-based interactions
- social setting similar to a face-to-face setting
- sense of place; sense of presence, being there

Before I discuss with you about the 3D virtual geology field trip and our reflections on its design and development, I will give you a brief background of our 3D initiatives in teaching, learning and research at our university.

I think for us, as a distance education institution, 3D virtual environments provided a number of opportunities: we were able to bring our students for tutorials – specifically those students who were unable to attend tutorial face-to-face due to mobility or family constraints.

We were able to provide students with a platform for meetings for groups projects.

Students formed their own self-help groups and were supporting one another.

So we have seen the 3D affordances in play - in our evaluation studies with students who said to us about how they felt that the setting here was similar to a face-to-face setting; how they felt a sense of place, sense of presence and a sense of being there together.

Projects in Second Life



- socialisation for synchronous and asynchronous collaboration
- team working in distributed teams
- design of 3D learning spaces
- navigation and wayfinding in 3D learning spaces

We have combined research activities with our teaching and learning in virtual worlds.

So, we developed a framework that guides an educator about virtual worlds such as Second Life facilitate early socialisation which is an important antecedent to collaborative activities in wikis, blogs, discussion forums and also in face-to-face settings.

In fact, our research has shown that students tend to collaborate better in asynchronous discussion forums after having met in a virtual world such as Second Life. We also investigated how Second Life could support team working in distributed teams in group projects in a Software Engineering module.

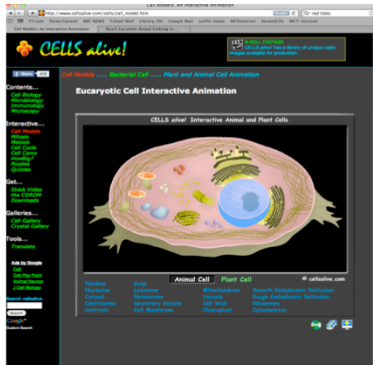
In addition, we received some external funding to carry out two projects: how to design learning spaces in Second Life, and guidelines for navigation and wayfinding in 3D learning spaces.

All our articles are listed here and most of them are open access:

<http://oro.open.ac.uk/view/person/sm577.html>

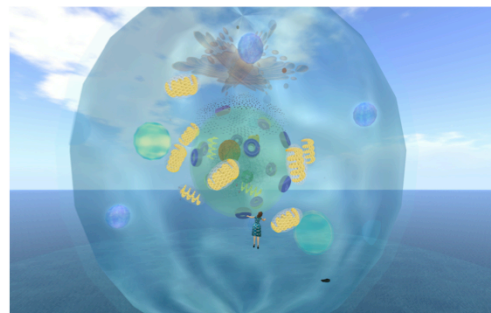
We have applied some of the guidelines in developing the 3D virtual geology field trip.

Learn through 3D simulations



Learning about an animal cell from a website

Immersive learning by moving around in the cell and its organelles



The trustees of the funding body – Wolfson Foundation visited our university prior to funding the Open Science Lab.

So, I will first share my experiences of what we demonstrated to them to highlight the role of 3D virtual worlds in education and training.

I was asked to give a presentation on 3D environments.

These are some of the examples I took: for example...

Comparing the picture or 2D representation of an animal cell with a 3D simulation on the Genome island in Second Life and how the student experience differs in these two settings.

Practise real-life scenarios through role-playing



Learn about trauma management
Get acquainted with the surgical equipment and the environment



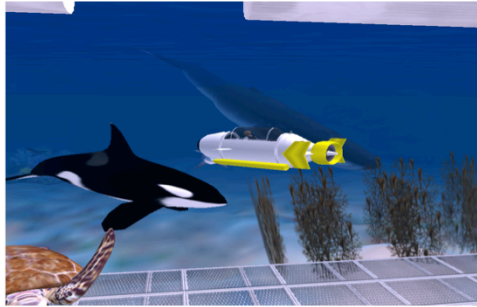
Other applications: for spatial recognition skills - building inspections, accident analysis, crime scene investigations, industrial safety inspections

I also gave them the examples of how Second Life and other 3D virtual environments enable students to role-play or practise scenarios before they perform in real-life settings: such as...

Learning about trauma management for a medical student or a medical student getting acquainted with the surgical equipment and the operation theatre environment before real-life operations.

I also highlighted the role of 3D environments in enacting our scenarios that require spatial recognition skills such as building inspections, accident analysis, crime scene investigations, and industrial safety inspections.

Explore unrealistic scenarios



Explore situations and places which may not be feasible or too cumbersome to arrange in real-life

Experience marine life virtually and at a close distance by taking a tour in a submarine



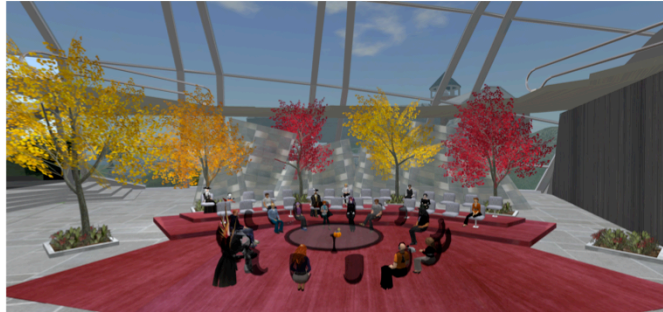
Studying underwater marine life

I think these examples from The Abyss Observatory impressed the trustees the most: ...

About how you can practise or enact scenarios which may not be feasible or too cumbersome to arrange in real-life.

For example, how students can experience marine life virtually and at a close distance or taking a tour in a submarine to study underwater marine life.

Institutional perspective



- Second Life is owned by Linden Labs
- our limited control in access or availability
- is not perceived for education alone

Working or Incorporating 3D virtual worlds in our institution has always been a challenge for some obvious reasons...

such as Second Life is a software that it not owned by us and, therefore, we have limited or control over its access or availability...

So, if we plan to bring our part-time students in and if Second Life is not available in that time slot – then, it would be difficult to explain to our students who are anyway studying with us under some severe time-constraints.

Also, the perception that Second Life is not for education alone – in fact, the same argument could be for Web – so, I don't think that this is a major hurdle to overcome.

Funding from Wolfson Foundation



- scope to demonstrate interactivity
- realism and high degree of fidelity
- sense of being there
- helps internalise the sense of exploration
- scope to integrate non-realism for enhancing learning and student engagement
- chose 3D virtual geology field trip

Against this backdrop of me being convinced about the significance of 3D virtual worlds in education, peer-to-peer learning, procedural learning, and so on, we have still had this resistance at the institution level

So, when we received this funding, we wanted to use a Science activity that had scope to demonstrate interactivity...

We could show the realism and high degree of fidelity..

Give students the sense of being there...

But also help internalise the sense of exploration...

And the scope to integrate non-realism for enhancing learning and student engagement...

We chose the 3D virtual geology field trip.

Field trips at our university



Attribution: <http://www.flickr.com/photos/neilt/58566273/in/set-1264989/>, and <http://www.flickr.com/photos/itsaboyd/6040957070/sizes/l/in/photostream/>

- 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

At our university, we have field trips two or three times in a year which are tutor-led

But if the weather is not helpful, students are not able to cover all the sites that had been planned for them

Not all students can go for the field trip

It is very much a first-come-first-served scenario

Some can't go because of age, mobility, family constraints...

We provide students with a DVD that covers all the sites of the field trip – this DVD is for reflection for students who were able to make it to the field trip.

For other students who were unable to go, the activities on the DVD help in knowing more about the field trip and for practising the concepts and fieldwork.

Why virtual fieldwork?



<http://www.see.leeds.ac.uk/current/fieldwork/equipment.htm>

But virtual field work is anyway important
...weather can hamper field trips

No, really: why virtual fieldwork?



- distance learning – sparse provision
- accessibility
- support real fieldwork
 - familiarisation before
 - revision/reflection after
- introduction to fieldwork
- ‘beyond fieldwork’
- Resources (costs)...



Distance education – there is anyway a sparse provision of real field trips

Accessibility and mobility are constraints

Also virtual field trips can support real field work


Such as preparation and familiarisation

Revision and reflection after a field trip

It can be a key introduction to basic fieldwork skills

Also, schools and higher education institutions may have resource-constraints

What we built



Unity Web Player | WebPlayer

100 km² area
low- res terrain maps, X-section

6 detailed sites
higher res hand specimens
task lists

Navigation
guided (linear)
free-roaming
teleports

Chat
range adjustable

Support
manual, transcripts

The Skiddaw field trip in the Lake District of the UK is an integral part of Earth science teaching at the OU

Students carry out a field trip with their Geology educators in the Lake District.

The application that we developed in Unity 3D is based around a 10km x 10km low/medium detail model of the terrain and LiDAR data around Skiddaw...

...with overlaid aerial photography, and including walls, trees, buildings etc.

There are six sites; students can go from one site to another; or they can teleport to any site

each site has rock specimens that you can pick up and view under a virtual microscope

There are rock sketching activities

We have provided a compass within the environment

There is an in-built text chat facility

The webpage of the 3D Skiddaw App within the Open Science Lab

[https://learn5.open.ac.uk/course/format/sciencelab/section.php?](https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=skiddaw_1)

[name=skiddaw_1](https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=skiddaw_1) has all the supporting materials: a quick start guide; a user manual; a study guide, transcripts of the audio material within the App; and a fieldwork toolkit (available to those who have access to the Open Science Lab and to the Skiddaw App).

Unity 3D engine: benefits



'3D' landscape – geology in context; spatial literacy

Rich interface – interactivity, rich resources, guidance, scaffolding

Self-contained – (mostly): limited external or linked material

Multi-user – transforms virtual field trip experience, especially for distance learners

'More than fieldwork' – do something different:

- flying
- aerial views, map overlays
- in-world cross-section
- teleports (time-saving)



Using Unity 3D or developing a 3D environment has various pedagogical benefits:

Build a '3D' landscape – students are learning geology in context; providing them with spatial literacy skills

Develop a rich 3D interface – interactivity, rich resources, guidance, scaffolding

Self-contained – tutorials and activities are all within the 3D environment; limited external or linked material on the website

Multi-user – transforms virtual field trip experience, especially for distance learners

'More than fieldwork' – do something different:

- Flying
- aerial views, map overlays over mountains: geological map, ordnance survey map
- in-world cross-section of a mountain that shows the variety of rocks in the area
- teleports to various sites (time-saving: not having to walk to individual sites)

Realism: 3D 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

Realism characteristics of the 3D App are:

First: in the design of the environment or landscape

- LIDaR data
- Photogrammetry data
- 3D modeling to weave it together

Then the learning activities are similar to a real field trip: for example, choosing the equipment, learning to use the compass, sketching rocks

This video on YouTube shows the realism aspects:

http://youtu.be/5_h4NI3AvCY

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

Non-realism (things you can't do in a real field trip)

- being able to microscopic views of rocks within the environment
- draping maps on the landscape
- viewing cutaways into the mountainside to see the geology underneath

This video on YouTube shows the non-realism aspects:

<http://youtu.be/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

A rich assemblage of linked learning resources within the context of a real-world landscape; a convenient place for students to engage with innovative practical science activities

A personal learning environment that will help internalise the sense of exploration; A group learning environment and, hence, a social experience – resulting in the building of team spirit and staff-student relationships

The capability for conducting activities above and beyond what is feasible during a real field trip – for instance, aerial fly-throughs for panoramic views, seasonal changes, scale changes from regional geology to close-up and microscopic views of rocks, or cutaways into a mountainside to see the geology beneath

An opportunity for contextual learning, that is, being able to explore, observe and gather data within the context, e.g. using a virtual microscope

A venue for development of fieldwork skills: investigating rock characteristics, observations, note-taking, sketching, synthesis, comparison of localities

A virtual environment that is complementary to real field trips such as for enhancing briefings and de-briefings of real field trips; or to facilitate completing of observations and discussions after a real field trip; or allow multiple virtual visits for getting acquainted with the landscape and its geology

Wider access: it may help to overcome the disadvantages faced by mobility impaired students, or students who are in other home-bound situations; or where there are too many students in a class and a real field trip may not be feasible; or to facilitate international participation of students and experts

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

Limitations are:

Learning the risk-awareness skills – falling, being aware of the edges of mountains

Challenges of being outdoors – whether it is the clothing and shoes; how to protect yourself in intense heat; what to do in emergency situations?...

...the limitations of conducting observations and measurements in a real field environment

Challenges posed by the weather – to keep your field notebook and other instruments dry

Challenges of using the equipment – encountering unfavourable weather conditions - for example, reading the instruments in strong sunshine

How to work collaboratively under the challenging conditions of weather or just being outdoors? It requires a different kind of social skills than collaborating online

Project team (1)

Open University

Shailey Minocha – *leader, virtual worlds*

Tom Argles – *geologist*

Brian Richardson – *OSL production manager*

Kat Garrow – *OSL project manager*

Sara Hack – *graphic designer*

Nick Braithwaite – *OSL Co-Director*

Sarah Davies – *academic consultant*

Trent & Peak Archaeology

David Strange-Walker – *LiDAR, photogram*



Project team (2)

Daden Ltd

David Burden – *project lead*

Paul Rahme – *programmer*

Macdonald Mbaya – *programmer*

Darrell Smith – *project manager*

Tim Lozinski – *graphics/
environment*

Iain Brazendale – *programmer*

Lucy Smallwood-Rose –
administrator



Daden Ltd (external developer)

<http://www.daden.co.uk>

David Burden – *project lead*

Paul Rahme – *Unity 3D programmer with Second Life and other data
visualisation experience*

Macdonald Mbaya – *Unity 3D programmer*

Darrell Smith – *project manager*

Tim Lozinski – *graphics/environment/3D modeller*

Iain Brazendale – *programmer and with experience on both 2D and 3D
projects*

Lucy Smallwood-Rose – *administrator*

Lessons learned: production



- trade-off: detail vs performance
 - limited high-resolution sites
 - hand samples data-heavy – alternatives?
- intense development
 - prepare comprehensive spec
 - frequent Skype meetings
 - site visit essential for developers
- multi-user functionality transforms experience
- combat fear that virtual field trips will replace real fieldwork teaching



Some lessons that we learned

We could not have high resolution environment everywhere

Compromise between the size of the build/file and the resolution

So only those places where the students carry out the activities are highly high-res but the rest of the environment is low-res

Rocks – real samples were photographed and brought in the environment – again very data-intensive

Therefore: trade-offs between realism, student learning and experience and size of the (executable) file that has to be run for the 3D App

It was quite an intensive development process: it was a funded project – but could we devote so much of time and energy in non-funded projects?

So, we had to prepare comprehensive specs; have frequent skype meetings and the site visit was essential for developers to see for themselves what they were developing for us

However, the achievements were that colleagues who were sceptical about avatars became so convinced that multi-user avatar-based functionality transforms student learning experience

We were also able to combat fear that virtual field trips will not replace real fieldwork teaching

Reflections: Unity 3D project



- internal team roles
- external development team
- communication technologies and protocols
- log of all decisions and next steps
- requirements creep
- flexibility in the funding

We had two teams – an internal team – project manager, subject expert, a production manager

External team who had the flexibility to bring in experts as and when required

They brought in a 3D modeller at a very short notice

They had two Unity 3D experts on their team

We also set up regular meetings and protocols: so, every Friday early afternoon, we would get the build from the developers; on Monday, we had a project meeting over Skype where we shared our thoughts

The meeting notes were recorded and logged as actions for the developers

Requirements did creep as we wanted avatar names to appear, or we wanted users to be able to have texting facility, or we added a number of accessibility features – so, our entire application is keyboard navigable

So it is always good to have 10-20% extra amount of funding that you would expect to spend when you prepare for the budgets of such projects

Reflections: Unity 3D project



- pedagogical principles
- designing in-world and web-based materials
- user experience: navigation, wayfinding, interaction, consistency principles
- iterative evaluations from multiple perspectives

Integrating subject or discipline specific principles: what should be included in the virtual world? what should be on the website?

Or which aspects students should practise in real life rather than in a virtual environment...

So, in this project, our Geology academic insisted that students should learn to sketch in real notebooks; how they should learn to maintain a geological field notebook

Usability of the environment is paramount – as students will be mostly coming on their own to practise and learn

Tutorials on the use of the environment – embedded within the environment but also a pdf file available on the website for students to download and learn about the application

Followed the principle of consistency – so, after we designed the first site, the other five sites were designed around the same principles of interaction and navigation

Iterative evaluations – throughout the process of design and development, as a team, we were performing different roles: a subject-expert looking at the pedagogy

I was looking at the 3D aspects; another colleague was looking at the accessibility of the application

One colleague was focussed on the graphic design – the design of the Head-

Questions



- For URLs, copy of the presentation, etc.: please don't hesitate to contact me

Author/presenter

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LinkedIn: <http://www.linkedin.com/in/shaileyminocha>

Second Life (avatar): Shailey Garfield

Details of the 3D application

The Open Science Laboratory (introduction):

<http://www.open.ac.uk/researchprojects/open-science/>

The Open Science Laboratory (activities):

<https://learn5.open.ac.uk/course/view.php?id=2&page=1>

3D Virtual Field Trip:

https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=skiddaw_1

Demonstrations on YouTube:

Video 1 (realism aspects): http://youtu.be/5_h4NI3AvCY

Video 2 (non-realism): <http://youtu.be/MOdu5jQukUk>

Video 3 (site 1 and key features of the 3D App): <http://youtu.be/zfbA1s9uRoU>

Papers and other presentations: