Introduction
Geological models have long been used in teaching but recent developments in digital 3D geological modelling and visualisation methodologies at the British Geological Survey may revolutionise the teaching of Geosciences.

How can 3D models help learning in the Geosciences?
3D geological models enable a student to observe, manipulate and interpret geology; in particular the models instantly convert two-dimensional geology (maps, boreholes and cross-sections) into three dimensions which is a notoriously difficult geospatial skill to acquire.

- Models can be used either to teach geoscience to complete beginners or add to experienced students body of knowledge (whatever point that may be at). Models could therefore be packaged as a complete educational journey or students and tutor can select certain areas of the model or educational material to incorporate into an existing area of the syllabus such as a field trip, project work or a certain taxing geological concept such as dip and strike.
- 3D models as an educational package can easily be utilised by students unable to attend university conventionally (for example due to illness or disability), distance learning students or for extra curricular activities and continuing professional development courses.
- 3D educational geological models can be used repeatedly and in such a way as to continually build on geoscience aspects – this practice will improve the students's spatial thinking strategies.
- 30 geological models can be compared with that seen directly in the field which aids the student in recognising particular patterns or sequences. It also demonstrates how different and complex geology looks in the field and thus how important it is not to rely on models alone!

University Requirements and Ideas

Questionnaire to Universities

Project Overview
3D geological models have great potential as a resource for universities when teaching foundation geological concepts as it allows the student to visualise and interrogate UK geology. They are especially useful when dealing with the conversion of 2D field, map and GIS outputs into three dimensional geological units, which is a common problem for all students of geology.

Today's earth science students use a variety of skills and processes during their learning experience including the application of schema's, spatial thinking, image construction, detecting patterns, memorising figures, mental manipulation and interpretation, making predictions and deducing the image construction, detecting patterns, memorising figures, mental manipulation and interpretation, making predictions and deducing the future; therefore we should continue promoting our 3D models for teaching as models have proved useful when dealing with environmental problems. Therefore educational research of student learning in earth science may also improve environmental decision making.

Conclusions
Using 3D geological models for teaching isn't new but current technology is and is likely to continue into the future; therefore we should continue promoting our 3D models for teaching as models have proved useful over 170 years.

- Use education strategies as they can alleviate problems that some students have with spatial skills.
- Develop geospatial skills and confidence in using the 3D geological models first.
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- Case study sections shouldn't be too long or complicated and should adhere to good communicating science activity and continuing professional development courses.
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The Subsurface Viewer
The viewer is a tool for displaying a three dimensional model of an environment which has been created by a geologist. The current version is mainly intended for modelling non faulted units although a newer version is able to add faults. There are tools in the viewer which allow the user to interrogate the data such as the horizontal section tool, the synthetic borehole log, the vertical cross section tool and unit manipulation.

Units can be coloured to represent different properties, a few of the themes which have been applied so far are the Name of unit, Engineering description, Permeability, Compressibility, Foundation conditions and Function. The model can be expanded to examine each unit as an individual component. (Terrington et al)

Building a 3D Model
The 3D models which are shown here are all built using GS13D (Geological Surveying and Investigation in 3D) which uses borehole data to create surfaces of each geological layer. These layers are then calculated into the units which you can see in the model. Once the model has been built, the geologist can then transfer the data into the subsurface viewer which can be used to display and interrogate the geology.

References
Rapp, D. N. and Uttal, D. H.