

Exploration of a first year university multimedia module on field geology

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As part of the teaching programme within a first year university unit on the earth's physical systems, a 'virtual reality' field trip has been developed to support field studies relating to geological materials and landscape history. This module aims to increase student understanding of the use of geological features in the evaluation of geological / landscape history. The module has various applications in the curriculum. For students attending a weekend excursion, the module is available as an adjunct to actual field studies and can be used by students as either a digital pre-lab or as an excursion review tutorial. For students not attending a weekend excursion (i.e. off campus students), it is used as a digital 'virtual reality' substitute for field site inspection. The module has simple linked interactive and dynamic image base digital media that provide a framework in which the geology and landscape history of excursion sites can be explored. This module is delivered as a website via CD, but can also be integrated with the 'online interface' for this unit via a QuickTime reference movie loaded inside a relevant 'Deakin (University) Studies Online' web page. The latter strategy enables assimilation of large multimedia files into online teaching formats.

Keywords: Earth & environmental sciences, field studies, landscape history, computer assisted learning

Introduction

The first year teaching programme for the Bachelor of Environmental Science degrees at Deakin University includes a core unit on the earth's physical environments / systems. In content, this subject is broad in that it includes studies on the geosphere, hydrosphere, atmosphere and responses of the biosphere to global environmental change. One component of the 'geosphere studies' includes practical and field exercises pertaining to geological materials, processes and landscape history.

The overall educational objectives for this practical component of the unit is for students to (1) develop basic skills in the identification of common geological materials (minerals and rocks), (2) gain baseline proficiencies in the reading of topographic and geological maps and (3) advance their appreciation of the linkage between field geological features and landscape history. This training is aimed at providing environmental science graduates with a simple practical geoscientific knowledge base applicable to the general evaluation of environmental problems with an earth science aspect.

The field geology teaching programme includes (1) exercises undertaken in the field during a weekend excursion and (2) a CD 'virtual reality' (VR) multimedia field tour of excursion sites and their geological and landscape features (distributed with practical manual / student guide). The geological sites visited on the actual and virtual reality excursion include folded and faulted Ordovician sandstones and mudstones originally formed in deep marine environments, Permian tillites formed by ancient glaciers and Pliocene volcanoes that are still visible as topographic highs (hills) on the landscape.

Modes of implementation

Implementation mode 1

Students attending a weekend field excursion associated with this unit (mainly on campus students) are directed to undertake preliminary explorations of the field sites utilising the Virtual Reality Geology

Excursion programme in association with explanatory text provided in an accompanying excursion handout. This ‘field pre-lab’ activity has an awareness raising purpose and students are encouraged to attempt excursion exercises utilising this multimedia resource prior to the actual field trip. Students more fully address the tasks relating to field geology exercises on the subsequent excursion (with the assistance of demonstrators). Final write up of the excursion report for assessment may also involve use of the Virtual Reality Geology Excursion to review (and reflect upon) the geological features of field sites after the actual field excursion. This latter activity is likely to be of particular educational value in the event of inclement weather on the day of the excursion. Under such circumstance landscape features normally viewed from distant points during the excursion may be obscured and student concentration can be affected by uncomfortable exposure to the elements. The rationale for teaching strategies employed during the field geology programme is to provide a variety of routes for student learning as a way of maximising student comprehension. This teaching model is ‘constructivist’ in its emphasis (Honebein *et al.*, 1991; Warne & McNaught, 1995; Neo & Neo, 2001 amongst others), with individual students building their own internal conceptual framework as a result of interactions with diverse field and ‘virtual field’ learning environments. The ‘Actual and Virtual’ field experiences of students are moulded to provide an authentic ‘landscape history perspective’ relevant to theoretical lecture and practical classroom learning of earth geo-systems and geo-materials (Figure 1). As outlined by Driver and Bell (1986) learning outcomes depend on both the learning environment and on what the learner already knows. Similarly, Neo (2003) commented that a constructivist learning environment is one in which students fit new information into a pre-existing knowledge framework and in the process actively progress understanding. In accord with these views, the field visualisations of the actual and virtual geology excursions provide frameworks in which students can build an appreciation of the way that disparate geological concepts, features and materials are manifested and integrate within real physical landscape settings.

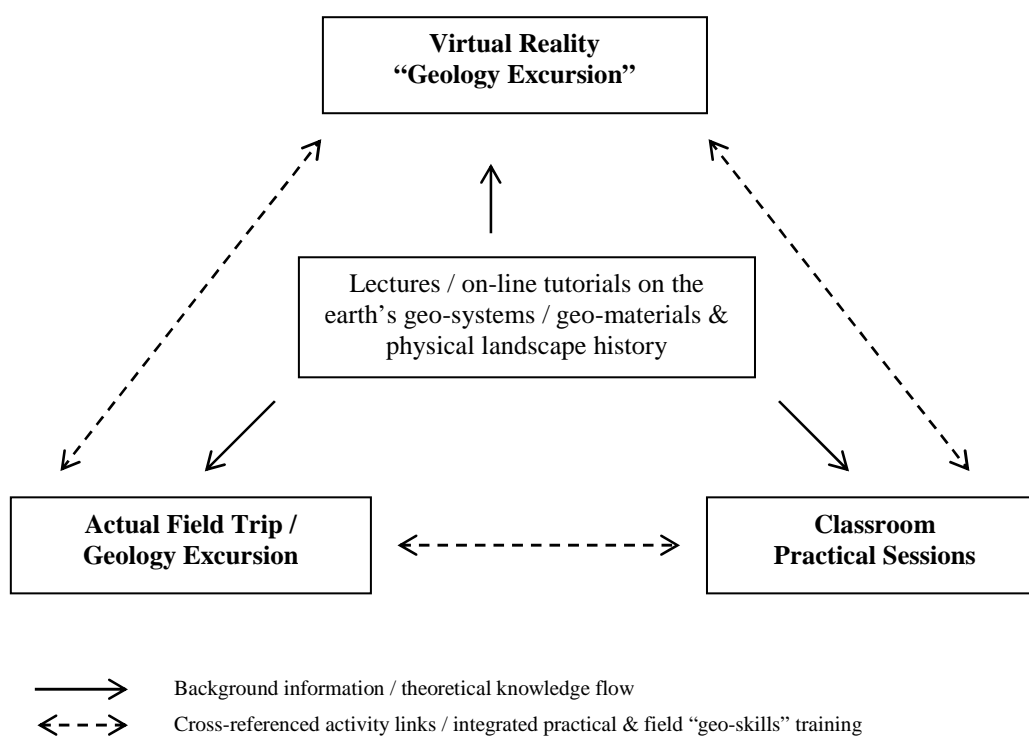


Figure 1: Interrelationship between teaching strategies for the geology component of a first year Deakin University unit on ‘The Physical Environment’

Implementation mode 2

Students not attending the weekend field excursion (mainly off campus students) are directed to utilise the Virtual Excursion Geology Excursion in a different way to students who attend the actual excursion. These (non-attending) students are directed to undertake three reading assignments, utilising textbooks and journals in the university library, on three theoretical aspects of the curriculum that are related to

excursion field sites. Armed with the knowledge gained from these reading assignments, students are then directed to view the excursion sites via the Virtual Reality Geology Excursion (on CD) and identify and interpret related field / landscape geological features. In this more directed use of the Virtual Reality Geology Excursion, the 'reading assignments' substitute for 'field demonstrations' provided by teaching staff on the actual excursion. Both 'reading assignments' and 'field demonstrations' provide conceptual contexts in which students can identify field geological features and interpret landscape history on the excursion and / or through use of the VR CD.

Virtual field geology in the environmental science curriculum

The main purpose of studies on the 'earth's physical environment' at Deakin University is to provide Bachelor of Environmental Science students with a background in Earth physical materials and landscape forming processes. The Virtual Reality Geology Excursion associated with this study programme, is designed to be viewed by students independently of formal timetabled classes. The first section examines rock outcrops and landscape features pertaining to relatively young (Quaternary) volcanic activity of the Keilor Plains west of Melbourne, Victoria (Australia). Much of the landscape in this area of Melbourne has been covered by lava flows that issued from Mt Cotteril, Mt Kororoit and other hills (past volcanoes) in the district. The second section deals with older rock of Permian age outcropping on the banks of Lake Merrimu near Bacchus Marsh, Victoria. These rocks are of glacial origin and date to a time when glaciers covered Gondwanaland. [This is an ancient giant continent, which included Australia, Antarctica, South America and other modern day continental 'fragments'.] These 'glacial rocks' are a relic of past geological ages and are so old that they have little linkage with modern landscapes. The third section examines still older (Ordovician) rocks and associated fossils from an old slate quarry near Bullengarook, south of Gisborne, Victoria. These outcrops beautifully contrast rock features derived from initial depositional processes with those caused by subsequent rock deformation events. They also yield a range of well preserved marine fossils (graptolites). Each of these sections uses QTVR movies and other interactive features that link rock outcrops to detailed views of rock and fossil materials. The Virtual Reality Geology Excursion is presented in a form that facilitates the integration of field observations with lectures on geological processes and laboratory practical class studies on geological (mineral, rock and fossil) materials.

Multimedia applications for university field studies

University subjects that focus on the study of aspects of natural history in one of its many guises (botany, zoology, ecology, geology, physical geography) often rely on field based studies as a platform for practical studies. However, there are pressures within the current university education environment that mitigate against field based teaching including; cost considerations, insurance and liability issues associated with government 'OH & S' legislation, and availability of students outside normal university teaching periods. These issues together with the increasing focus on computer based technologies in teaching provide some significant challenges for field oriented university subjects.

In addition, 'natural history' subjects typically possess image rich teaching resources. High resolution interactive digital resources for these subjects can involve multimedia that are not easily deliverable online to student populations in all circumstances, because of the varying quality of computer related technologies accessible to student end users (particularly off campus students). It is perhaps no coincidence that some of the many successful online subjects / courses principally involve either text or number oriented online communications with an absence of extensive, computer memory intense, interactive visual media. As a consequence, the digital 'Virtual Reality' field - based teaching materials discussed here were developed using integrated 'QuickTime® Virtual Reality' (QTVR) software delivered as a website on CD. It can be merged with the 'online interface' for this unit via a QuickTime reference movie loaded inside a relevant 'Deakin (University) Studies Online' web page. The latter approach thus facilitates the integration of large digital multimedia files into online teaching formats.

The use of QTVR software to simulate field studies

Classically, QuickTime VR software (+ clone software) is used to create virtual reality multimedia through the construction and integration of three different types of graphical digital media items termed

(1) *Panoramas*, (2) *Navigable Object Movies* and (3) *Scenes* (see outlines in - Apple Computer, 1995, Schafe and Clarke, 1997; Comer, 1999 amongst other references). In summary, a *Panorama* is a 360° (or less) image that is assembled as a cylinder centred on a single point of observation. From this point, which is termed a *Node*, an observer (viewer of the computer screen) can manoeuvre the image to face in any (usually horizontal) direction via 'dragging an icon' in different directions on the screen (via operation of the computer mouse). *Panoramas* are most commonly created by taking a series of overlapping photos around a single point, digitising these and then stitching them together to create a continuous cylindrical image through which it is possible to move in an continuous, usually horizontal fashion. *Navigable Object Movies*, which can be created for selected objects within a *Panorama*, are media items that are typically constructed to be manoeuvred in a continuous horizontal and vertical fashion. Operating *Navigable Object Movies* from within a *Panorama* is accomplished by mouse clicks on visible or invisible *Hot Spots* associated with an area / item on the *Panorama*. *Scenes* are a suite of linked *Panoramas* (*Nodes*) with their associated *Navigable Object Movies*. In *Scenes* viewers can steer from node to node via mouse clicks on 'navigating' *Hot Spots* and hence simulate movement about the *Scene*. Moving through a *Scene* and operating *Navigable Object Movies* is, in effect, a computer screen replication of a walk through a real location in which it is possible to make close up inspections of selected objects within the scene. It is these technical capabilities that make this technology particularly suitable for constructing virtual reality field study exercises (Warne *et al.*, 1996; Pereira & Brilha, 2000; Merguerian *et al.*, 2002).

For the Virtual Reality Geology Excursion outlined here a modified development model was adopted. Individual nodes (panoramas) were linked via html pages, precluding the need to load all nodes at once when operating this multimedia module. This meant that smaller file sizes were used in the operation of this module facilitating increased viewing speeds and general ease of use.

Design features of the virtual reality geology excursion

In designing the VR environment an initial decision was made to give as much space as possible to the VR movies. The rationale for this decision was – the larger the dimensions of the movies, the more immersive the environment. As the point of the CD is to give the student a virtual (authentic) experience, it was felt that the virtual space created by the VR movies had to be one that filled their vision. Therefore the required QuickTimeVR movies were created at an optimal size for delivery as a package via CD - in the region of 640 X 480 (pixels) each in dimension. This meant that there was not much room left for other features, although a small number of other elements critical to the functioning of this module were 'squeezed' into the rest of the 800 X 600 of overall space available per VR movie (Figure 2). These include:

- A compass to orientate the student. This was build into the VR movies, and as we took a compass reading at the time of shooting the scene (taking initial photographs), the compass that displays inside the movie is reasonably accurate;
- A map of the region with basic pin points to indicate where nodes were shot;
- Roll over images of site locations to assist with navigation;
- Thumbnails of different rock types found at each location, which when clicked on, opened a pop up window containing a close up of the rock specimen selected.

There were a number of innovative developments undertaken for the VR movies themselves. Not all movies were 360° (or less) images assembled as a cylinder centred on a single point of observation. One movie of a linear rock face (see Feature 2 in Figure 2) was constructed as a flat linear image ('*pseudo panorama*') with operation of the movie simulating a walk along the rock face. Another movie of the three dimension relationship between two particular rock structures (see Features 6 & 7 in Figure 2) was constructed as a rotatable object ('*pseudo navigable object movie*') with operation of the movie simulating a 'walk around' of the rock exposure exhibiting these particular structures.

With respect to the overall appearance of this multimedia module all of the screen 'pages' were designed to have a near identical look. The reason for this design specification was that since this multimedia module had a relatively high level of interactivity, consistency of interface facilitated student learning of the operational environment. Relatively little explanatory text was incorporated into this multimedia module in order to facilitate flexible application within the curriculum.



Figure 2: Two screen grabs from the virtual reality geology excursion

Feature 1 = Interactive locality diagram. Feature 2 = flat linear VR movie ('pseudo-pano.'). Feature 3 = roll over images of site locations triggered via locality diagram interactivity. Feature 4 = Interactive compass (directional) readings of landscape view seem on computer screen – triggered by operation of VR movies. Feature 5 = Thumbnails of different rock types found at each location, which when clicked on, open as a pop up window containing a close up of the rock specimen selected. Feature 6 = 'walk around' VR movie ('pseudo navigable object movie'). Feature 7 = Interactive graphic linked to feature 6 – its purpose is to facilitate visualisation of 'walk around' perspective.

Interactive software used for the virtual reality geology excursion

QuickTime® is a multilayered container that supports a diversity of media types and has its own programmable language. The main function involves 'clicking' on a movie, holding down the mouse

button and dragging the movies mostly left or right (Gulie, 2000). [Some up and down movement is also available.] The movies in the Virtual Reality Geology Excursion in fact consist of one big movie, which acts as a container for other movies - essentially movies within a movie. On each VR Geology Excursion page we see a VR movie track, a movie track that contains the compass, a graphics track which contains the background, a text track for the titles at the top and a sprite track which contains the interactive code to (especially) link together the compass and VR tracks.

The field site VR movies each contain HOTspots that contain links to web pages. They also have other attributes that run Javascript on mouse roll overs. In this multimedia module the HOTspots are visible but they can be hidden if desired by the user.

The VR movies were initially created with RoundAbout Logic software 'Nodester' (no longer produced). The movies were subsequently compiled and coded in TotallyHip's 'LiveStage Professional'. 'LiveStage Professional', is a Quicktime editing tool that utilises a timeline structure to manage movies, construct multiple tracks and code movies for interactivity.

Learner evaluations and teacher reflections

One of the main aims during the development of the Virtual Reality Geology Excursion was to build visual frameworks in which students could construct an appreciation of the linkage between geological features and landscape history. Therefore an important question arising from the use of the Virtual Reality Geology Excursion was whether or not this multimedia module really did assist students' visualisation of geological materials and features within a field / landscape context. In order to determine this matter a questionnaire addressing the issue of 'visualisation' was distributed to students. A questionnaire was chosen as the preferred tool to survey student opinion because of the diverse contexts and times of student usage of this multimedia module.

Of note, Laurillard (1993) has commented that the use of digital resources [such as this Virtual Reality Geology Excursion] may provide students with far more sophisticated materials for doing their own analysis [i.e. answering excursion questions] than has been previously made available to them in the course of their university studies. In circumstances such as this, students may require special instruction in analytical methods related to the use of these digital resources, and to the context of their application, to effectively meet intended learning objectives. This viewpoint is borne out by the varying levels of success re student usage of the Virtual Reality Geology Excursion (see discussion below).

Of the 148 (2003) students who participated in the 'real' field excursion component of the unit, 34 student responses to a written questionnaire on the effectiveness of the CD resource were received. In general, responses can be categorised broadly on the basis of the type of usage by students of this Virtual Excursion Geology Excursion.

Use as a 'pre-lab' by students attending actual field trip

As part of their general preparation for the actual ('real') excursion, students attending this field trip were encouraged before hand to (1) read the written excursion handout (includes site explanatory notes and questions) and (2) preview the excursion sites using the Virtual Reality module on a supplied CD. Relevant individual responses by students on the evaluation questionnaire to the question "Do you consider that the Virtual Reality Excursion programme assisted your 'visualisation' of the excursion site geology?" included:

Yes it was fantastic. It gave me a great knowledge and grasp of the areas we would be visiting. It also helped greatly in answering questions.

[Virtual] excursion sites gave [me] an idea of what we would be covering and what to expect. Complimented the lectures, pracs and excursion well.

Yes indeed, it was good to get an overview prior to attending [the excursion].

Yes, I think it helped touch [on] the subject before being thrown straight in.

Yes, it was easier to complete the set tasks at the different sites because of knowing what the site looked like.

Yes, it assisted me because I knew what to expect and I understood what [the demonstrator] was explaining better.

Computer programme gave me a good idea of [the] geology of the sites before [the] excursion.

Yes it did. I could focus on details [as] I had background knowledge helped [in that I knew] what I was looking for.

Excursion sites gave [me an] idea of what we would be covering and what to expect. [It] complemented the lectures, pracs and excursion well.

Despite the above comments, and even though there are detailed introductory explanations given for each excursion site in the excursion handout (and symbols that link handout content to the CD), relatively few students were able to, or attempted to generate preliminary answers to excursion questions using the Virtual Reality Geology Excursion CD (based on verbal feedback from students). This may be partly a consequence of students requiring demonstrator instruction and discussion, which is provided on the actual field trip, to confidently answer the relevant excursion questions. It might therefore be concluded that, without the provision of a better method for contextualising excursion site 'visuals' on the Virtual Reality Geology Excursion, this multimedia module in its current form is of limited use as an excursion pre-lab. As previously noted, the field visualisations of the Virtual Reality Geology Excursion are intended to provide frameworks in which students can build an appreciation of the linkage between geological features and landscape history. The problematic value of the Virtual Reality Geology Excursion as a pre-lab may relate to students having difficulty in making conceptual links between geological theory (considered in classroom studies), and related virtual field views of geological features. This problem may be overcome in the future by the insertion of audio or video clips of demonstrator field instruction, into the multimedia module, and / or by the integration of pertinent readings assignments designed to prime student understanding of relevant field geological features (see further discussion below). As a rider to the above conclusions, it is worthy of note that there may also be an issue with student motivation given that no assessment imperative exists for students to undertake this pre-lab exercise, if they attend the actual excursion.

Use as a 'review tutorial' by students attending actual field trip

Post excursion review of the excursion sites using the Virtual Reality Geology Excursion was also an option available to students who attended the field trip. On the basis of verbal feedback, this was a common use of the Virtual Reality Geology Excursion. Relevant individual responses by students on the evaluation questionnaire to the question "Do you consider that the Virtual Reality Excursion programme assisted your 'visualisation' of the excursion site geology?" included:

Yes definitely, you pick up things on the computer that you may miss at the actual site. [It was] very helpful.

Yes, being able to look at particular [sites] as it was hard to complete on the excursion with so many people [in attendance].

Yes, I thought the third site was great [in] assisting my visualisation because it looked exactly like the actual location.

It was ... helpful to go back and visit the sites after the excursion.

Yes, [it] helped fill in gaps that we may have missed while on actual excursion.

..... and I [could] review these sites after excursion.

For students who attended the actual excursion, a significantly appreciated aspect of this multimedia module was the ability to visually 'revisit' excursion sites after the actual field trip during the preparation of their excursion report for submission.

Use as a standalone virtual excursion by students not attending actual field trip

Students not attending the excursion (i.e. some off campus students) are required to undertake a field study programme that integrates reading assignments on certain topics (glaciers, volcanoes and mountains) with related questions associated with the Virtual Reality Geology Excursion. Fifteen students fell into this category (in 2003) of which 6 returned evaluation questionnaires. Relevant individual responses by students on the evaluation questionnaire to the question - "Compared to the study of textbooks and other reading materials, did the use of the *Virtual Reality Excursion* enable you to better visualise geological materials and features relating to glacial, volcanic and mountain building processes?" - included:

Yes, the Virtual Excursion was very useful. It helped me better understand certain aspects of the reading material. It was just as good as being there.

Yes, especially seeing [real examples] as a lot of the material [in textbooks etc is] hard to visualise.

Yes, visually seeing the materials and features helped [me] to recognise and name specific rocks in real life situations.

Students who utilised the Virtual Geology Reality Excursion as a standalone experience of excursion field sites generally presented reports of a consistently high quality. This perhaps reflects a relatively deep level of understanding of field site geology facilitated by related 'forerunner' reading assignments, which seem to have had the effect of appropriately contextualising the field geology visuals of this multimedia module. It appears that the reading assignments used in this way are useful tools for priming student understanding of field geological features presented in the Virtual Reality Geology Excursion. The converse is also probably true, as suggested by student questionnaire responses, which indicate that the visualisations in the virtual excursion enhanced their understanding of textbook presented explanations of geological features and processes. Typically, students undertaking this mode of field studies approached unit teachers for further verbal explanations pertaining to the preparation of their field report submission. This latter teacher input may be substituted in the future by the additional insertion of audio or video clips of demonstrator field instruction, into the multimedia module.

Student acceptance of virtual excursion learning materials

In general, based on the questionnaire responses received from students (in 2003), the majority indicated a high level of acceptance regarding use of 'field oriented' Virtual Reality multimedia within the curriculum. The majority of students indicated that they thought that the computer programme aided their understanding of the relationship between geological processes and landscape features (i.e. for students who attended excursion - 24 positive responses out of a total of 34). For instance, one student commented that:

I think the visual aspect of learning about earth processes and features is very important to [the].... understanding [of] such large scale concepts.

A total of 30 students (out of the same group of 34 students) responded that they would like to see more of this type of computer assisted learning (virtual reality excursions) to support field studies. However, based on verbal feedback, it is worthy of note that 'real' field excursions remain a well appreciated learning experience by students undertaking geoscientific study programmes.

Summary

The Virtual Reality Geology Excursion created to support geological field teaching provides a very useful resource for delivery of (1) alternate modes of field geology study, (2) backup support for field teaching

diminished in effectiveness because of inclement weather and, (3) acts as a vehicle for enhancing a field perspective of mostly classroom presented geological concepts and processes. Evaluation has suggested that a future useful development for this Virtual Reality Geology Excursion might be to add short audio or video clips of demonstrator explanations of field site geology, to accompany current QTVR and associated interactive features of the multimedia module.

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