Google Earth, virtual fieldwork and quantitative methods in Physical Geography

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Introduction

The application of quantitative methods in physical geography, and in particular geomorphology, is an important skill for students as it enhances understanding of the subject, as well as developing generic skills in numeracy and computation (QAA, 2007 Geography document). There is strong evidence to suggest, however, that there has been a decline over the last 15-20 years of fluency in the basic mathematical skills of students accepted onto degree courses (Engineering Council, 2000). This includes geography, where students with insufficient mathematical skills 'view quantitative material with antipathy' (Folkard, 2004). The development of new teaching and learning methods focused on student understanding of quantitative methods is, therefore, of increasing importance. The recent development of Google Earth provides an exciting new teaching resource for geography (Patterson, 2007) and allows the opportunity for developing innovative teaching and learning methods centred around virtual fieldwork. Following the approach of Wagner (2000), Google-Earth was considered by the authors as a means of 'sneaking mathematical concepts through the back door of the… classroom'. Seminars were designed to combine virtual fieldwork using Google Earth with spreadsheet application of equations to stimulate student interest and understanding of quantitative methods. The objectives of this paper are: 1) to present examples of teaching resources developed for a second year undergraduate Geomorphology course at Royal Holloway; 2) to examine student opinions towards the use of Google-Earth seminars for their learning experience; and 3) to briefly reflect on the use of virtual fieldwork seminars and their future development within Geography curricula.

Google Earth teaching methods and resources

Two new seminars were designed for the second year undergraduate Geomorphology course at Royal Holloway (2007/08 academic year), with the aim of improving student understanding of quantitative methods. The seminars were centred on small-group teaching (<20 students *cf*. Griffiths, 1999) based in a computer teaching laboratory. The seminar content was designed to link virtual fieldwork using Google Earth with the application of equations in Microsoft Excel.

Fluvial processes of the Brahmaputra River

This seminar was designed to support the fluvial geomorphology section of the course and focused on the concept of stream power (Eq. 1) by comparing how it changes downstream along the Brahmaputra River.

$$\Omega = \rho g s Q \qquad \text{(Eq. 1)}$$

Where: Ω = stream power (Ws^{-1})
ρ = density of water (1000 kgm^{-3})
g = acceleration due to gravity (9.81 m^{-2})
s = slope (m/m)
Q = flow discharge (m^3s^{-1})

The parameters ρ and g are constants, so in order to calculate stream power, the students were required to determine the slope and flow discharge. The latter cannot be calculated from Google-Earth, so the data was derived from a published journal article, Sarma (2005), where average flow data for various monitoring stations along the Brahmaputra River was presented. The students were asked to calculate, using Google Earth, the slope of the river at the monitoring station locations. The Google-Earth measuring tool can be employed to measure longitudinal distance, and spot heights could also be taken up- and down- stream, so that the average slope of the river valley could be calculated. It is relevant here to mention one caveat in the use of Google Earth for virtual fieldwork, namely that the accuracy of Google Earth is not sufficiently high to enable precise height measurements, which is especially relevant for an alluvial floodplain with limited relief. The design of the seminar, therefore, needs to take this into account and in this case the Sarma (2005) paper presents slope data along the Brahmaputra so that students could compare their 'field' data with those presented in the paper. The key point of the exercise was not that the students' fieldwork methods were accurate but that they were actively engaging with the stream power equation and physically calculating them in a spreadsheet rather than simply listening in a lecture. The students were also asked to describe the morphology of the river at the different study sites to identify changes in the river's character that could be linked to changes in stream power and fundamental river processes.

Glacial processes in the Himalayas

The aim of this seminar was to support key concepts introduced in the glacial geomorphology lectures, including the shear stress equation (Eq. 2), and to investigate the dynamics of glaciers through the interpretation of glacial landforms.

$\tau = \rho_i gh \sin a$ (Eq. 2)

Where: τ = shear stress (Pa);
ρi = density of ice (900 kg/^{m3});
g = gravity (9.81 ms^{-2});
h = ice thickness;
a = slope angle.

The density of ice and gravity are constants and the students were provided with realistic hypothetical ice thicknesses *(h)* for different glaciers. To complete the parameters necessary to calculate the shear stress, students were asked to determine the slope angle using Google Earth. Unlike the fluvial exercise, the glacial sites have much greater relief, so reducing the errors associated with the spot height measurements. This exercise enabled the students to compare the shear stresses of different parts of a glacier and relate this to the glacier morphology. In addition to the quantitative exercises, the students were asked to explore the landscape downstream of a particular glacier to determine whether the glacier was advancing or retreating and to identify key geomorphological evidence to support their view.

The student perspective on virtual fieldwork

In order to assess the value of the Google Earth seminars for the student learning experience, a focus group approach was used. Two focus groups were attended by 7 and 8 students (*cf.* Folkard, 2004; Breen, 2006), representing 60% of the student cohort. The sessions were chaired by a member of Royal Holloway's Educational Development Centre (EDC), were recorded digitally to MP3 file using an Edirol digital recorder and the files sent for transcription so that the student responses remained anonymous. Amongst other questions, the students were asked to identify five things that they liked and disliked about the Google Earth seminars.

Overall the students were positive about the use of Google Earth in the classroom. One key feature of the responses was that the students thought it was a good approach to support the lectures as it gave them the opportunity to explore the different landscapes and environmental settings and so was more interactive than a normal lecture:

> *"I liked that you could actually see what we discussed…good to actually put it in context not just having a photo but could look at it in 3D…"*

> *"…it is easier now that you have been able to visualise it… helps bring it* [the subject] *together."*

The students were generally enthusiastic about Google Earth and had not considered it as a potential teaching and learning resource – most had used it but not for educational reasons. One benefit of Google Earth identified by a student was that it is:

> *"…something that you can also do at home…"*
> *EDC: "Do you think you will use it in your spare time…?"*
> Student: *"Absolutely."*

One of the key objectives of the seminars was to help student confidence in the use of quantitative methods through the application of various key geomorphological equations:

> *"…you could apply what we were learning in terms of equations….thought it was really interesting."*

> *"I was having a bit of trouble with the calculations that we had in the first term… when you actually use them you get a grasp on what the equations are actually representing and what the figures show."*

The second comment above is interesting, as all the Google Earth seminars in this trial were run in the second term. Clearly this student found it a great help for their learning and understanding of the equations to actually play around with the different numbers in the equations and analyse the results. When asked about their confidence in the use of equations, one student responded:

> *"Greatly increased. Much better, much better."*

Discussion

The key aim behind introducing the Google Earth seminars to the second year undergraduate geomorphology course was to increase student confidence in the use of quantitative methods, so it was particularly pleasing to read the students' positive comments about their increased confidence in the use of, and interest in, quantitative equations. The students were unanimous in their view that the seminars should continue in future years. However, despite these initial positive comments, there is still scope for improving the virtual fieldwork seminars, both in terms of seminar content and delivery, and integration into the wider curriculum.

With respect to teaching resources and content of the seminars, it is interesting to compare the fluvial and glacial seminars described above. The general student perspective was that the linking of the virtual fieldwork to a published article was of benefit to their learning. From a teaching point of view, a well designed seminar that links a virtual field site to a paper that provides relevant value added data is important to avoid problems with the inherent quantitative inaccuracies of current Google Earth programmes. It is crucial that the teacher is aware of these inaccuracies when designing seminars, but not be put off by them. In terms of what can be achieved, it is our belief that the learning process and student interest is stimulated and enhanced. Clearly the scope for quantitative virtual data collection is limited using Google Earth, but it also has benefits, such as the ability to 'fly' around the study area, zoom in and out, and rotate and tilt images, which enable sophisticated interpretations of the landscape that may not be apparent through aerial photographs or a conventional field trip to the same locality. There is, therefore, clearly great potential in using Google-Earth for teaching about: 1) landforms, their formation and response to environmental change; and 2) environment-society interactions. The widespread availability of Google Earth, and its increasing spatial resolution across the globe, means that virtual fieldwork can be successfully embedded within geography curricula as an additional learning resource, with the caveat that in times of increasing pressures on fieldwork (Boyle, 2007) it should not be considered as a replacement but as a link between field and classroom.

A final consideration to discuss briefly is that of assessment. At Royal Holloway, students were provided with worksheets to work through during the seminars. Some of the questions were purely mathematical, others asked for more discussion about the results and their relevance for features of the landscapes they were studying. The aim of this was to enable additional formative assessment for the students. However, one criticism that emerged from the student focus groups was that due to demands elsewhere in the curriculum for assessed coursework many students did not put any effort into the write-up. Those that did, however, produced interesting pieces of work. This has implications for the ways in which such seminars may be used in the curriculum and there may be a case for adjusting the balance between exams, coursework essays and virtual fieldwork seminars so as to diversify the range of assessment. These issues are currently being examined for the second year Geomorphology course at Royal Holloway.

Conclusion

In this paper we have presented two seminars developed for a second year undergraduate geomorphology course that linked virtual fieldwork using Google Earth with spreadsheet application of quantitative equations. Although there is still scope for improvement in the design and delivery of the seminars, the students were positive in their appraisal of the new seminars. Despite the limitations of Google Earth, such as the accuracy of the measuring tool, it is believed that well designed virtual fieldwork seminars can be a valuable addition to the physical geography curriculum. For virtual fieldwork seminars to be effective they should be designed so that: 1) the study area has high resolution coverage with Google Earth; 2) the exercise can be linked to a published article that provides context about the site and/or additional data; and 3) the students are provided with an interesting and challenging formative or summative assessment exercise to complete in association with the seminar.

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