

# Blended technologies in Geographical Information Science: A curriculum approach



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**Abstract:** A series of case studies in the use of geospatial technologies to explore and enhance spatial thinking in HE curricula are presented. They blend traditional lectures and fieldwork with mobile computing, augmented reality and virtual reality techniques. The development of a modular set of teaching materials and digital models allows re-purposing for a variety of learning objectives across undergraduate and taught postgraduate curricula.

**Key words:** Blended learning, mobile technologies, augmented and virtual reality

## 1 Introduction

The work presented here forms part of collaborative research into the use of geospatial technologies to explore and enhance spatial thinking in HE curricula and beyond [1]. In particular, we have been exploring the use of mobile computing, augmented reality and virtual reality technologies to communicate spatial process and pattern in a teaching and learning context. In this paper, we report a variety of case studies, from various curriculum contexts, in which a number of 'modes of interacting' with geographical data and the associated technologies which enable them are adopted, in a way which "blends" [2] the new approaches with more traditional forms of teaching including field work. In looking at how we blend the pedagogic approaches themselves, we shall also highlight how the materials may be re-purposed and re-used for students at different levels within the curriculum.

## 2 Approach

### 2.1 Exploring past landscape histories

The first case study considers various techniques for students to augment real landscapes with digital representations of past landscapes (glacial model), hidden landscapes (geology drapes) and contemporary landscapes (RADAR digital surface models). The techniques (shown in Figure 1) include a lecture with a semi-immersive virtual reality component, and then in the field, simple augmentation with student-generated print outs, context-aware mobile computing [3] and real time visualisation using GPS-fed Google Earth on tablet PCs.



*Figure 1: Blending techniques and technologies for landscape visualisation*

At first year undergraduate level the technology is used as a means to an end, to engage students with issues of landscape history in the English Lake District in Cumbria. Field sketching and photography are also used, in particular for demonstrating evidence for geology - landscape relationships. For year 3 undergraduates and MSc in GIS students the same digital models and basic field exercise are used to enable a critical evaluation of how digital models can faithfully represent the real landscape. In addition the usability of the technologies themselves can form a focus, with each student group (of around 5-6) having the full range of techniques to evaluate side by side. Field activities are documented by student video diaries which are edited and used as part of the evening presentations but may also prove valuable in revealing how mobile technologies are used in a field context. The virtues of VR immersion in relation to fieldwork as discussed in [4] can be explored directly by students in relation to actual fieldwork.

## 2.2 GPS and mobile GIS

Our second example (Figure 2) illustrates a blend of lecture, computer laboratory, Virtual Reality (VR) and mobile teaching and learning approaches on the subject of GPS technologies with mobile geographic information systems (GIS) [5].

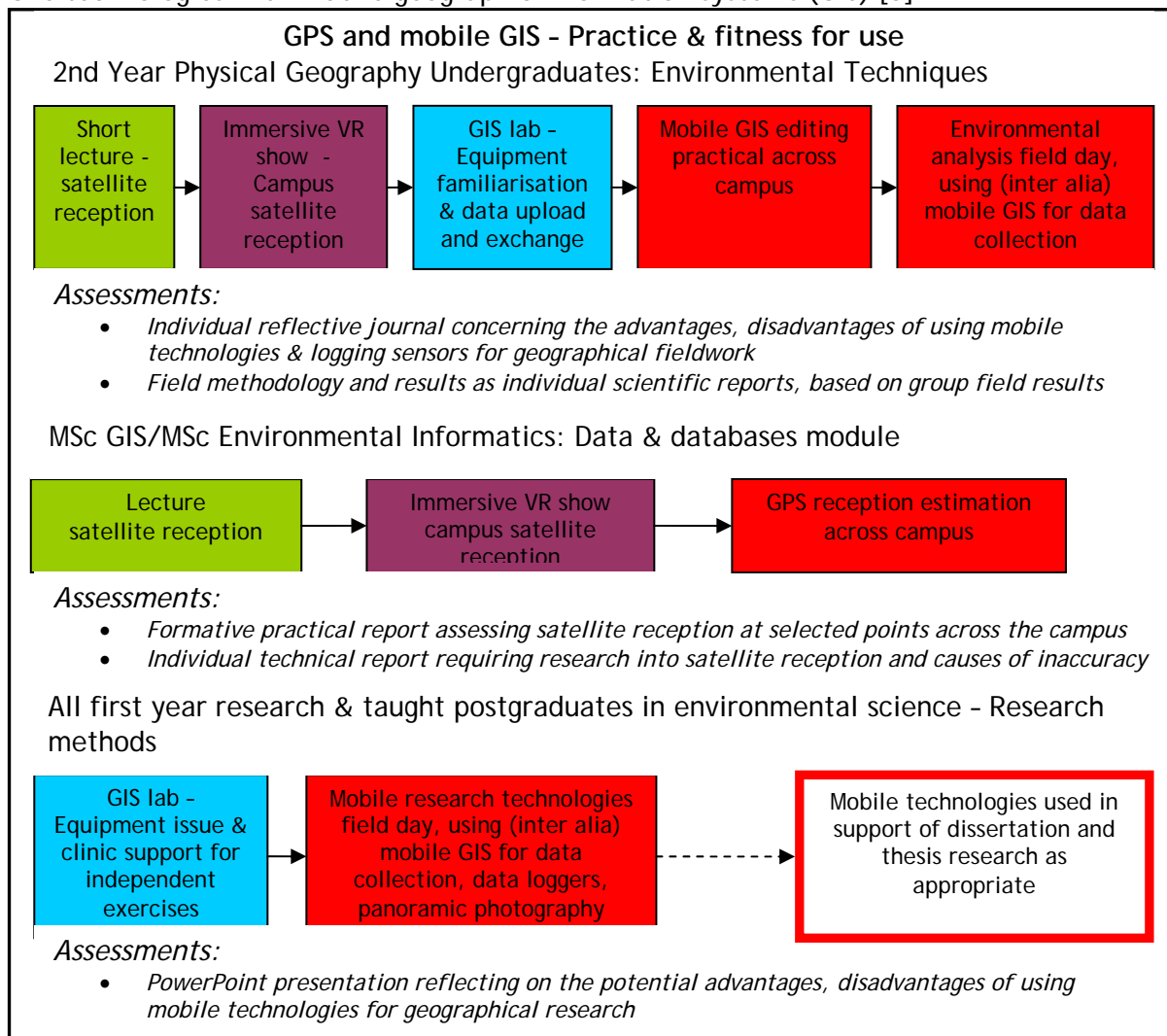


Figure 2: Example blends of lecture, computer laboratory, VR and mobile teaching & learning approaches in GPS technologies with mobile GIS.

The particular methodological sequence reported here has evolved in response to student feedback; of particular note, the virtual reality visualisation of GPS satellite reception across the campus, reported in more detail in [5] has mitigated student frustration in comparison to previous more traditional teaching and learning combinations. While further evaluative work is required, it would appear that asking students to familiarise themselves with mobile equipment and mobile GIS while at the same time managing variable satellite reception for the first time caused cognitive overload. Essentially, it became difficult for students to know which of several possibilities was causal in GPS signal outage; had they linked Bluetooth GPS and PDA incorrectly, were the settings between PDA and ArcPad software to blame, had the GPS or PDA turned itself off or otherwise malfunctioned (e.g. battery loss) or was GPS reception blocked by building configuration? By providing a pre-built visual representation of temporally averaged signal reception across the campus in the first instance, students were able to focus on learning other aspects of mobile GIS and equipment management, leaving an extrapolation of GPS signal understanding to an unfamiliar environment to the subsequent practical exercise.

While our original intention had been to provide materials and approaches across the blend to appeal to students with a range of differing learning styles, the outcome of the intervention appears to have been to scaffold learning via the provision of intermediate and more focused tasks. It would appear that while our ultimate goal is for students to use mobile GIS and GPS for independent and problem based goals as appropriate, introducing technologies too fast within complex scenarios has the potential to frustrate. While visualising representations externally prior to students forming their own fuller internal representation can be criticised as an approach that generally runs counter to deeper learning, the reflective journals evidence the fact that, in this case, students reached a point where they were able to evaluate which, when and where different types of mobile technologies could be used at the end of the range of exercises. From the perspective of Bloom's (1956) taxonomy [6], higher level learning was ultimately achieved via the blended approach.

### **2.3 Geovisualisation in the Geographical curriculum: Applications of GIS**

#### *2.3.1 The role of multiple representations in blended learning*

Example blends of lecture, computer laboratory and VR theatre approaches to the teaching and learning of cartography and geovisualisation more generally are shown in Figure 3. As the flow charts identify, lectures are intertwined with use of the virtual reality laboratory to facilitate the practical demonstration of visualisation issues. In the particular example reported, a lecture on crime pattern analysis is followed by an immersive space-time crime pattern visualisation for a street that is familiar to the students. This link between the general theoretical notion and specific space, tying initial internal representation to an external representation of the new but unseen (crime pattern representations) with the familiar (a street with student pubs and bars) appears to have been particularly powerful for the students, and was reported in feedback forms as being one of the highlights of the module.

#### *2.3.2 Postgraduate and undergraduate connections*

Also of note in this example are the connections between postgraduate and undergraduate work, and the re-use of material between and within modules; in some cases, virtual visualisations are used to illustrate technical issues such as the need for levels of detail in real-time visualisation while on other occasions the application context itself comes under student scrutiny and discussion. Further, 3D

modelling practicals at MSc level are used to extend the basis of the campus model used in the GPS example above. This approach highlights the importance of volunteer or participatory data both for the resource intensive process of 3D modelling and indeed within GI applications as a current research theme. Additionally, a subset of postgraduate students carry on to undertake technical or applications work in virtual reality, providing opportunities both to further enhance the student learning experience with virtual reality via the improved understanding of navigation and perception in virtual worlds and also to vary the range of applications that can be used to augment a variety of Departmental teaching (e.g. crime pattern analysis [7]).

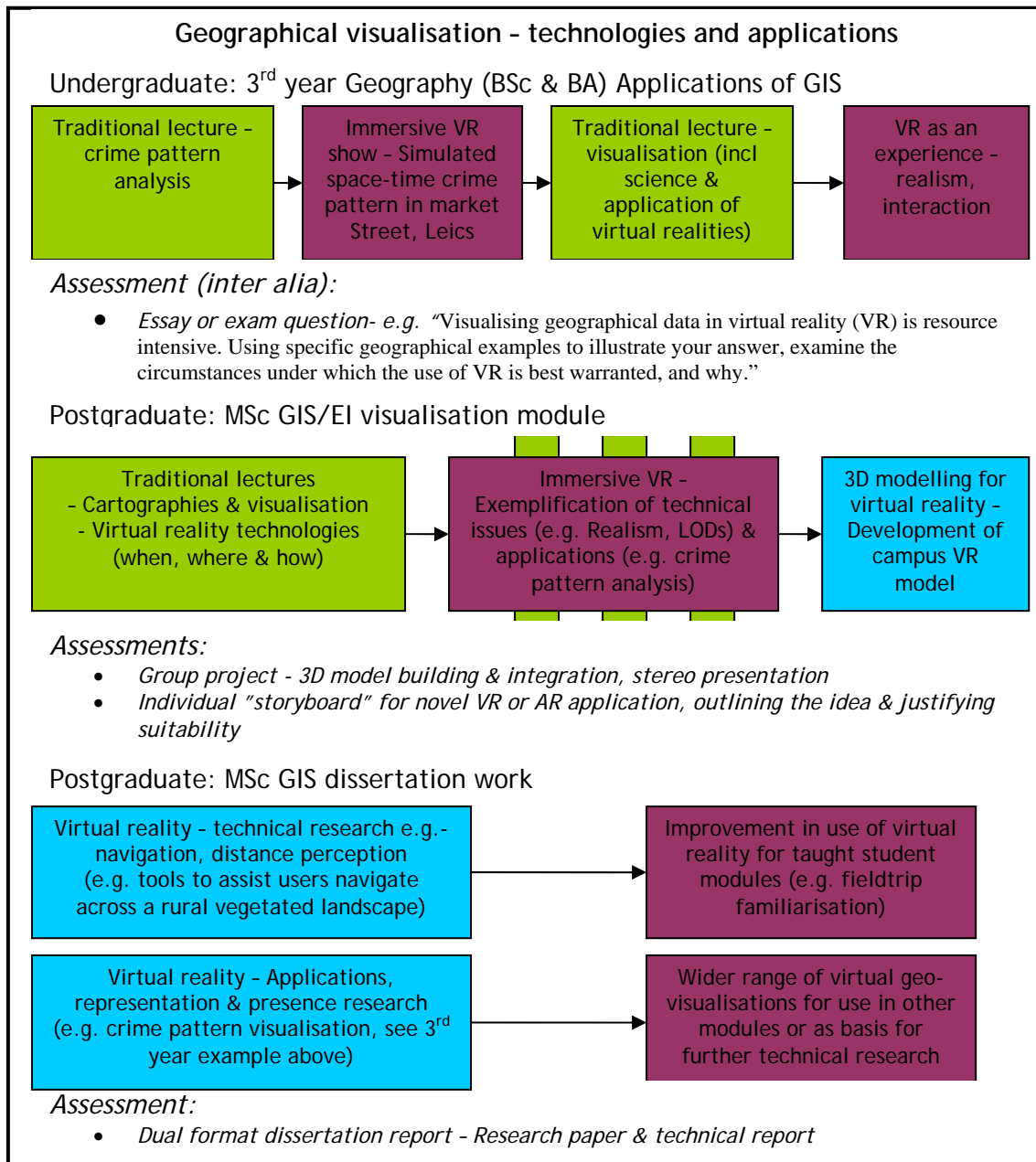


Figure 3: Example blends of lecture, computer laboratory, VR and mobile teaching & learning approaches in Geo-visualisation.

### 3 Discussion & Conclusions

The work has been carried out both within the sub-discipline of GI Science but also as a means of promoting the wider use of spatial data in both geography and other disciplines less often associated with geographical concepts.

In drawing together these examples, we demonstrate how a variety of pedagogic approaches from the traditional to those incorporating middle and higher-end technologies can be integrated together in a flexible, adaptive manner within different learning contexts.

While at one level, this re-purposing is intensely pragmatic, at another we show how our approach to re-purposing also links with concepts of scaffolding and building understandings as the students progress through their overall curricula.

A further pedagogic issue relating to the higher end technologies such as virtual and augmented realities in particular is that the development time for individual teaching and learning units can be significant.

### 4 Project Details

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