

# Learning to read the landscape: Interactive Visual Tools for exploring spatial thinking

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## 1. Introduction

The ability to associate a perspective '3D' view of a landscape with a map-like representation is one tangible component of spatial thinking as described by Golledge (2003). It is relevant to the understanding of how people read maps, how they interpret photorealistic visualisations of terrain models in various contexts including virtual field trips (Whitelock & Jelfs, 2005) and also has implications for the design of graphical aids to navigation and orientation (Augmentra, 2008). This paper will report on the development of an interactive game-like application designed to explore some of these issues and also to couple as a pre-fieldtrip orientation device in advance of a Geography fieldtrip held in Cumbria, NW England. The application is one of several being developed as part of a project entitled 'GeoSpatial Widgets' funded by the Visual Learning Lab (VLL) but also closely aligned to the aims of SPLINT (SPatial Literacy IN Teaching). Both the VLL and SPLINT are Centres for Excellence in Teaching and Learning funded by the Higher Education Funding Council of England (HEFCE).

The first application to be developed through the Geospatial Widgets project is *Locata*, an interactive web-based application which explores the ability of students to associate 3D landscape views with a 2D representation of the same region. The main aims of this application are:

- To explore the ability of students to reconcile 3D views of an area with an equivalent 2D map representation of the same area.
- To introduce students to Digital Terrain Models as representations of a region they will visit on a field trip, whilst familiarising themselves with the major physical features of that area.
- To explore the effectiveness of different 2D representations in supporting the user to locate a 3D view.
- To collect detailed log data recording the timings of each user interaction and the performance in relation to locating various categories of landscape view.

This paper describes the GeoSpatial Widgets project and in particular the *Locata* application including the software development environment, design issues and the potential significance of the log data being collected.

## 2. The 'GeoSpatial Widgets' project

The VLL aims to research, develop and raise awareness of effective visual learning practices and technologies. The GeoSpatial Widgets project has its origins in a VLL-funded project within the School of Chemical and Environmental Engineering at Nottingham called *Visual LabWidgets*. The aim of this project was to develop a series of virtual, visual laboratory experiments that could be accessed by a wide range of users. These Visual Labs were designed to both test and develop users' 2D and 3D visual and spatial skills while at the same time providing training in fundamental science and engineering concepts as well as strategic thinking and problem solving skills. A number of computer-based interactive applications were developed using the multimedia authoring

environment Macromedia® Director®. Although the virtues of interactive multimedia applications for enhancing learning have been promoted for some time (Najjar, 1998) some researchers would argue that the situation is less clear cut (Ainsworth, Bibby and Wood, 2002). The need for very careful design and an appreciation of the contexts of use of such applications are vital (Goldman, 2003). The Director® environment helped to allow the implementation of good design ideas *gaming* styles. This package was also used due to its ability to deliver powerful 3D graphics over the internet via the free, easy to install, Adobe® Shockwave® Player web-browser plugin. Developing predominantly web-delivered applications was considered an essential part of the project, providing an increased potential for student access. Examples of these Visual LabWidgets include a virtual polymerisation plant, a leaking pipe system, and a 3D noughts-and-crosses game (Figure 1).

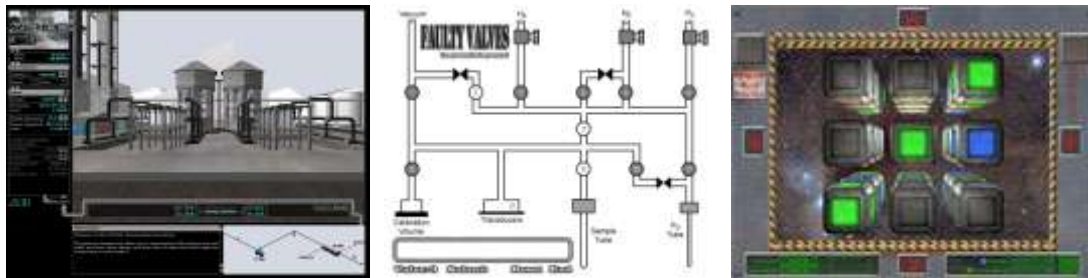


Figure 1 - Visual 'LabWidgets': Virtual Polymerisation plant (left), Fault Values leaking pipe system (centre), and 3DOX (right)

The *GeoSpatial Widgets* project utilises the same interactive visual framework as *Visual LabWidgets* but in a more overtly geographical context. Applications are being developed around a series of case studies focussing on aspects of spatial thinking, *Locata* being one such application.

Clark *et al* (2008) suggested that by focussing on a specific aspect of spatial thinking such as the interpretation of topographic maps it may increase our understanding of how to develop spatial skills tests, which incidentally are increasingly being developed using multi-media techniques.

A review of the relevance of cognitive and learning sciences to spatial thinking in geoscience education by Ishikawa and Kastens (1995) revealed the potential importance of 'constituent strategies' employed by users to locate themselves on a map. By capturing log data from the *Locata* application

### 3. The 'Locata' application

The landscape chosen for the first version of the *Locata* application is an area around Keswick, Cumbria, NW England. A radar Digital Surface Model (DSM) draped with colour aerial photography formed the virtual model from which perspective views could be rendered by the user within the Shockwave 3D environment.

Figure 2 shows the overall process flow of the application. Users are asked some simple questions about themselves and their familiarity with map reading, 3D computer applications and the geographical area via the start-up screen, before being presented with the main interface, shown also in Figure 2. Users are presented with a series of 3D views (upper right of the interface) selected at random from 100 pre-defined view locations generated from the Digital Terrain Model and attempt to drag a location/direction icon over the map to place the observer at a location where they believe the view was generated from.

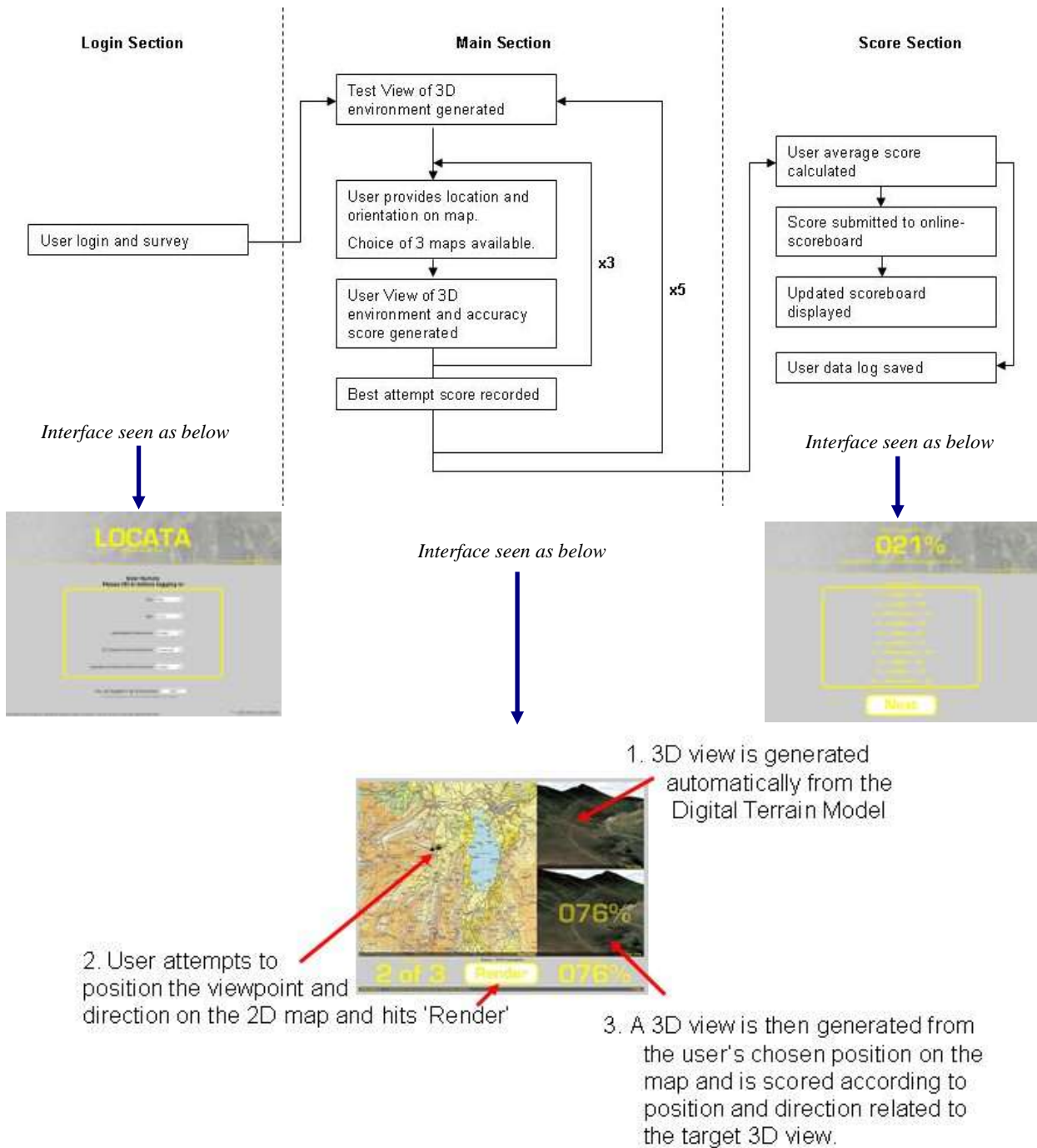


Figure 2. Flow diagram for the Locata application.

The user can select a different map backdrop at any time; Figure 3 illustrating two of the alternative 'map-like' representations currently offered in an attempt to explore their effectiveness to portray terrain in this context. When the user clicks 'Render' a 3D view is generated from the DTM from the user's current chosen viewpoint. A percentage score is generated and displayed on the basis of how well the position and orientation matches that of the target view. After three attempts the next random view is displayed, currently the application shows the user 5 different views. The average score for the session is displayed on a web-based high score table following a typical gaming model to provide an additional means to engage users in 'playing the game'.

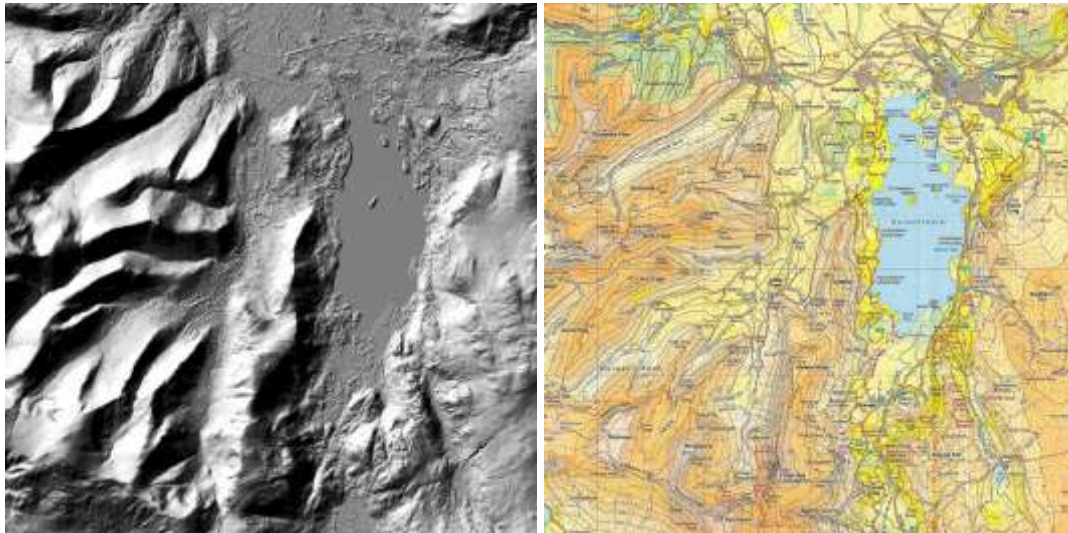


Figure 3 – The hill-shaded terrain model (left) and the Harvey’s Mountain Map (right) used in *Locata*.

In addition to the online scoreboard facility, *Locata* also remotely records data from each game played in the form of a text-based log file. An example of such a file is shown in Figure 4. The information recorded includes the survey data supplied by each user at the beginning of *Locata*, which is encoded to facilitate data searching and aggregation. The location and orientation of each test-view (TV), the reference number of the test-view, and the location orientation and score of each of the users three attempts (UV) are recorded for each of the five test-views. The user’s choice of map during the exercise (OS, R, HS) and the user’s final average score is also recorded (AS). The 100 test views had previously been classified into types based upon aspects of their composition and landscape context with a view to utilising this information in any subsequent analysis of the log data.

15:36:48	06/11/2007	lgzgp1M2C0S4S556			
00:00:00	TV	11.13	3.06	-171.25	4
00:00:13	R				
00:00:33	UV	11.89	39.02	-162.47	10
00:01:23	UV	8.38	11.74	-106.92	43
00:02:13	UV	24.09	-14.33	69.71	14
00:02:29	TV	35.82	38.41	123.11	96
00:04:03	UV	14.18	37.5	114.53	31
00:04:18	UV	26.37	33.84	114.53	58
00:05:22	UV	34.15	34.3	92.38	68
00:05:34	TV	-1.83	-19.21	-24.9	86
00:07:26	UV	-43.6	15.24	0	1
00:08:33	UV	44.51	-26.22	0	3
00:09:24	UV	44.51	-26.22	0	3
00:09:34	TV	19.05	0.3	-54.86	40
00:10:09	UV	13.11	-9.6	-66.37	55
00:11:27	UV	11.28	2.44	-72.25	62
00:12:02	UV	12.2	6.55	-79.11	55
00:12:26	TV	1.83	-10.06	39.8	70
00:13:17	UV	-3.66	8.99	-124.5	19
00:13:56	UV	-7.16	0.48	-124.5	27
00:14:26	UV	-16.92	-18.44	90	25
00:19:32	AS	40			
15:56:20	06/11/2007				

Figure 4 – Example of log data.

The purpose of *Locata* included pre-fieldtrip orientation and to introduce year 1 students to digital terrain data, however there is clear potential to analyse the log data being captured to address questions such as:

- Are certain classes of views easier, and quicker, to locate?
- Which type of 2D representation proved most popular in supporting observer placement?
- Do patterns emerge over the course of a session, or multiple sessions, in terms of the choice of 2D representation or overall performance?
- What were the characteristics of individuals who performed well?
- Are patterns evident in performance before and after a fieldtrip to the area?

The application has been tested with a large number of users during the development phase, the large majority being geography students. An early qualitative assessment suggests *Locata* is popular, and in some cases addictive, although it will be properly deployed during the Spring semester of 2008 with year 1 undergraduates, both before and after a fieldtrip to the centre of the region featured. One observation made during early testing is that when students worked in pairs they displayed very animated and geographically interesting commentary on where they thought the views were located and why, and this may be something to explore alongside a more rigorous analysis of the log data.

#### 4. Ongoing work within the GeoSpatial Widgets project

A configurable version of *Locata* has been developed whereby photographs or landscape paintings from known points on the ground can be used as the test views instead of the computer generated views from the terrain model.

A number of other applications are also being developed as part of the GeoSpatial Widgets project. Amongst these is a virtual orienteering application called *Virtualeering*, which simulates some of the basic characteristics of the sport of orienteering (McNeill, Cory-Wright and Renfrew, 1998). This application is based on the same 3D environment used in *Locata* but utilises different game mechanics and learning objectives. Within *Virtualeering* the user is able to navigate around the 3D virtual environment from a first-person perspective, and is required to visit a series of 5 waypoints which are marked on a variety of different map types (Figure 4).

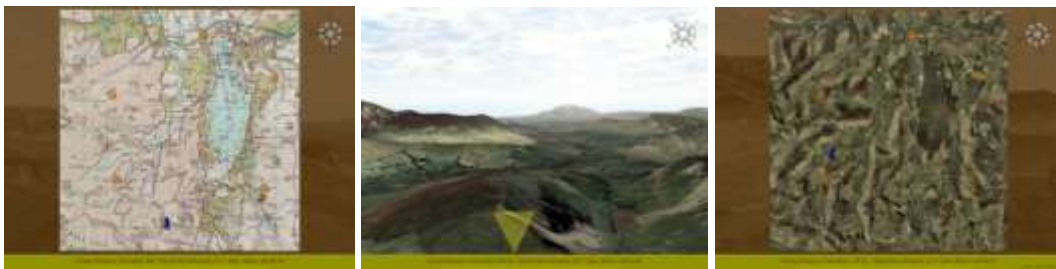


Figure 4 - *Virtualeering* initial map page (left), 3d environment with waypoint (centre) and photo map with path and location marked (right).

The user must plan their own path to visit each of the waypoints in the quickest time possible. The user's location and orientation within the environment can also be revealed on a map but this incurs a time penalty. As with *Locata* there is an on-line scoreboard facility as well as detailed data logging to provide in-depth information on each user interaction with the 2D and 3D versions of the environment used within the application.

Other applications explore different aspects of spatial thinking, including a real-time overland flow modelling environment and a 3D representation of neighbourhood cells in a water flow direction algorithm dynamically linked to lines of Visual Basic code as they are executed, this being deployed on a Masters level programming module.

#### 7. Conclusions

A game-like web-based application has been developed which introduces students to digital terrain data, familiarises them with a fieldtrip location but also engages them the process of interpreting various 2D landscape representations in building up a picture of the landscape. The log data captured during each session is stored, and along with audio or video recording offers potential for further investigation into this quite specific aspect of spatial thinking.

## Acknowledgements

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## Biography

Gary Priestnall is an Associate Professor within the GIS research group, School of Geography, University of Nottingham, whose research interests lie in geographic representation, landscape visualisation, and spatially-aware mobile applications for geography fieldwork. Jack March is a Research Fellow working on the HEFCE-funded Centre for Excellence in Teaching and Learning – Visual Learning Lab project 'GeoSpatial Widgets', developing game-like visual interfaces to support teaching in learning.