Towards improving spatial literacy for non-specialists: Developing Interactive, Integrated Geospatial Learning and Understanding (IIGLU)

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Summary: This paper discusses the user-centred design approach for developing an end to end framework for Interactive, Integrated, Geospatial, Learning and Understanding (IIGLU). Based on the premise that GIS are hard to use, IIGLU makes them easier by presenting learning and understanding of geospatial concepts embedded within discipline specific scenarios relevant to new learners outside the field of GIS. This paper explores a qualitative approach using semi-structured interviews and transcript analysis to define user stories which were turned into user storyboards for recording learning scenarios within our custom developed e-learning tool.

KEYWORDS: GIS in Education, GI Pedagogy, Geoweb, User Stories, Users

1. Background

Geographical Information Systems (GIS) can solve problems ranging from finding the shortest route between two locations to modelling the change over time of an archaeological site; mapping the area where dialects of a language are spoken or examining factors affecting the spread of disease. GIS are, however, under-utilised across a wide range of disciplines. In the literature, two main issues emerge as the front runners to their lack of use and poor rates of adoption: (1) the perceived (and real) complexity of Geographical Information Systems (GIS) desktop software packages) and (2) a lack of understanding as to what a GIS can do within the context of specific disciplines (Downs, 2006; Davies and Medyckyj-Scott, 1996; Clarke et a, 2007; Koch and Denike 2007; Klein, 2003).

Proprietary GIS software are notoriously difficult to use and the concept of simplicity has been neglected in preference for complex functionality; on first use they are often daunting, unwieldy and require significant user training (Davies and Medyckyj-Scott, 1996). Students find software packages such as ArcGIS and MapInfo unintuitive, and they require a lot of time, patience and regular practice to build up mental models of how the particular software systems work. Often there is a mismatch between the software designer's perception of ease of use and the real experience of the user interface as experienced by users. As a consequence, users waste time grappling with the software interface, instead of focusing on the actual task - such as engaging with and understanding geographical data and processes for problem-solving. In these circumstances, the development of mental models for understanding geographic concepts takes second place to concerns of trying to understand how to interact with the software.

Observations from the authors' teaching experience provide further evidence in support of the issues. A recent experiment conducted at University College London (UCL) asked twenty students on an MSc in GIS to perform a series of ten tasks using three unfamiliar GIS packages (MapInfo Professional, Geomedia Professional and Quantum GIS). The students had a theoretical understanding of the spatial concepts that underlie GIS and had previous experience with ArcGIS. They also had access to tutorials and online help and could ask their classmates for assistance. Despite this, comments such as "*very different functionality than that found in ArcGIS*", "*It is very frustrating using a new software. I didn't realise how much I had learned in ArcGIS*" indicate that

their understanding of GIS was linked to a specific software interface, rather than the underlying geographic mental model – they struggled to link concepts to functionality. In 4 cases out of 36, students did not manage to complete all ten tasks in on time, and all three packages were rated "difficult to use". These observations highlight the difficulties faced by users having some familiarity with GIS software and concepts. How much more difficult, then, is the learning situation faced by students outside the realm of specialist GIS courses, who do not have a basic understanding of GIS concepts and their application to their specialist domain?

The complexity of desktop GIS interactions is a stark contrast to the widespread familiarity with simple online reference mapping solutions such as Google or Bing Maps. Many students and staff in Higher Education are now unconsciously regular users of "*GIS*" in the form of online or smart phone applications. Tasks such as 'click on a point to find information' are common and well understood. This paper builds upon this commonality between online mapping and GIS, through the gradual introduction of users to geographic concepts via the development of an interactive, integrated geospatial framework for learning and understanding (IIGLU), enabling active learning.

The IIGLU framework comprises two components, one for teachers the other for learners. Within the framework is an e-learning environment, with two components: (a) a facility for teachers to record discipline specific geospatial tutorials and (b) to provide a facility for learners to playback and interact with discipline specific tutorials based on predefined relevant scenarios . Central to the success of the framework is first the notion of embedding the learning and understanding of geographic concepts within discipline specific scenarios that users outside of GIS can relate to. Secondly, learning material for geographic concepts is presented in an easy to use, interactive environment that does not distract users with complex interaction. Consequently, this paper will discuss the process behind developing the discipline specific scenarios and focuses on user-centred design.

2 Development of discipline specific scenarios

At the project's conception a panel of user experts was formed (see table 1), motivated by the need to continually engage with future end users and inform the development of IIGLU's functionality and interface. The engagement of users was critical to the creation of the domain specific-scenarios in which the geographic concepts could be embedded and to characterise their perceptions of geographical information tools within their disciplines. The creation of the scenarios comprised of five activities based upon a qualitative research methodology. (1) Plan and define semi-structured interviews (2) conduct interviews (3) code and identify themes in interviews (4) create background narratives to describe students (user stories) and then (5) develop and record scenario storyboards.

Table 1. Academic background of user panel

ID	*Academic Discipline of user expert panel*
1	Urban Historian
2	Urban Anthropologist
3	Urban Designer
4	Environmental Geographer

The semi-structured approach to the interviews enabled relevant discussions to emerge, allowing for the development of potential scenarios. Interview participants were provided with background data describing the project aims and objectives and each participant was informed that the results of the interviews would be used to formulate problem scenarios relevant to their discipline. The themes of the interview questions were as follows:

- GIS knowledge and map making experience
- Use of maps in their research
- Types of students, their computer experience

- Typical discipline specific issues that students encounter

Each interviewee was asked to describe their background and academic experience and to identify whether they used a particular reoccurring problem or situation to illustrate concepts to new learners in their field. Analysis of the interview transcripts revealed insights valuable to the IIGLU development process

2.1 Themes emerging from the interviews

Transcript analysis proved useful for a number of reasons. Firstly, themes associated with perception and use of digital mapping technologies emerged: (i) inherent use of maps or location specific information (ii) general IT literacy and software use and (iii) awareness and knowledge of digital mapping technology (GIS) / geographic data. Secondly, discipline specific problems informed the design of our discipline specific scenarios (see section 2.2). Figure 1 shows a summary of the interview with the user design expert.

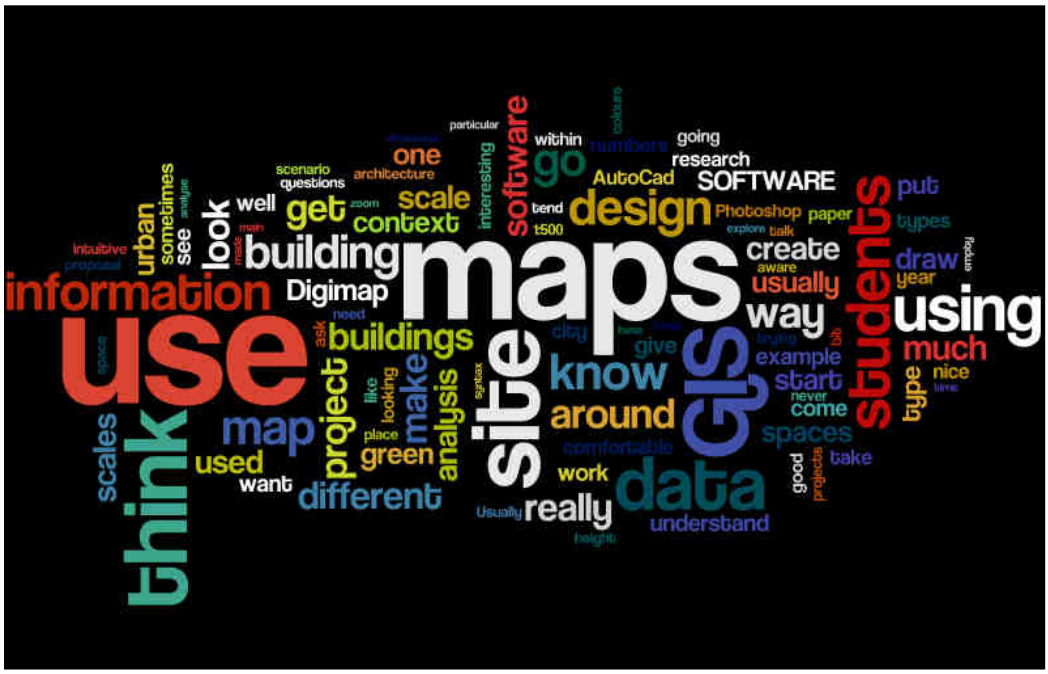

Figure 1. Summary of User interview with Urban Design Expert

2.2 Development of User Case/User Stories – background narratives

The transcript analysis enabled user stories to emerge. These stories act as a tool to summarise the user scenarios identified during the interviews. They characterise user needs, from which functional requirements of the IIGLU framework were then developed. For example, the following quote describes the user story of a student specialising in environmental management:

"Megan is an Environmental Manager who is responsible for organising Participatory Workshops which involve a range of stakeholders in the planning and management of water catchments (this is in accordance with the EU water Framework Directive). She has no prior mapping experience and is not very technical but is confident with desktop office software. She would like to identify low-income neighbourhoods from which participants can be invited to a workshop, in a suitable location. She would like to use a mapping application to do this but is not sure how to start making a map or what data are available to her."

3. Summary

The final step was to create a storyboard, a scenario comprising of a series of tutorials and tutorial steps to explain introductory geographic concepts such as (layers, symbology, map projections, scale). For the student of environmental management the scenario topic was focussed on rivers and river catchments. The final step in the learning framework was to record the scenarios using the specifically designed and developed software , see screen shots in figure 2. Where essential mapping concepts such as knowing why location is useful, modeling the world using points, lines, areas and the basics of layers could be introduced using river data (obtained from ShareGeo).

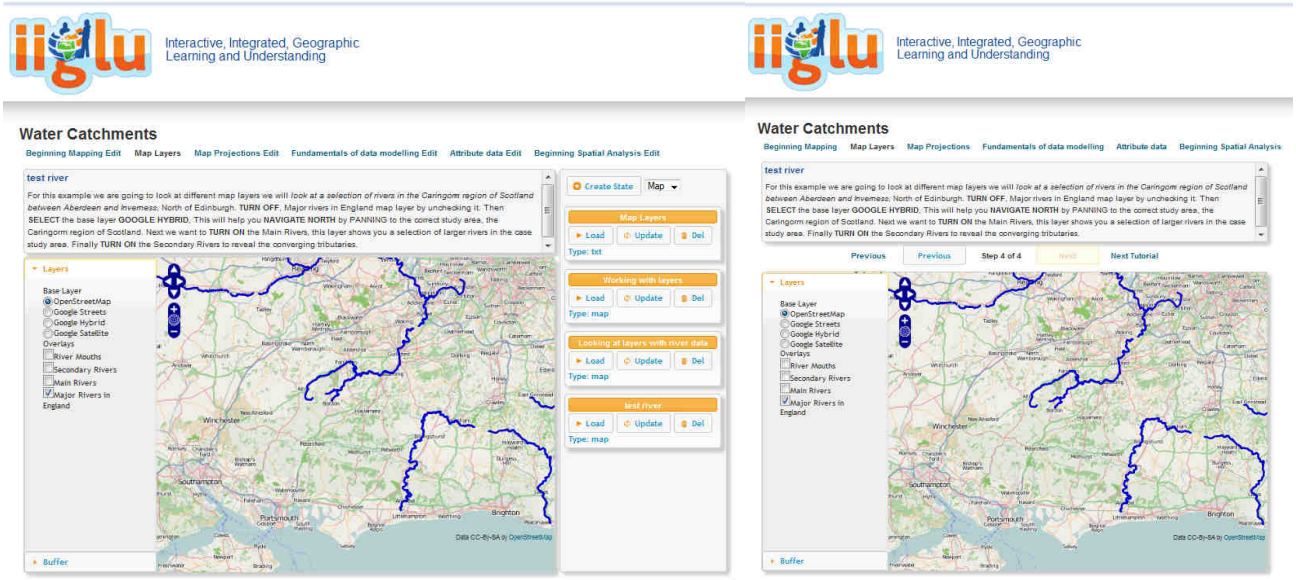

Figure 2: (a) Teacher recording and (b) Student play back of user scenarios

The IIGU framework was developed as an entry-level tool for introducing geospatial concepts to new learners from outside the discipline of GIS. By bridging the gap between desktop GIS and geoweb mapping applications, the IIGLU framework developed a user centric approach placing the learner at the centre of the learning experience instead of the software. In the pedagogical literature, teaching GIS is strongly influenced through the channels in which geographic information is presented to learners (Fargher, 2007). By embedding user stories into the development process, IIGLU facilitates self and active learning of geographic concepts by reducing the interaction effort required at the point of entry into the discipline.

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6. Biography

Dr Catherine (Kate) Jones is a lecturer in Human Geography in the department of Geography at the University of Portsmouth with 8 years expertise in delivering GIS projects. Having been awarded her MSc in GIS in 2003, she completed her PhD in 2008 and worked as a post-doc, leading the GIS development of an interdisciplinary project (2007-2009) - all at UCL. She is an expert within the field of cartography, usability analysis and useful and useable GIS for enabling and developing spatial capabilities for non-domain experts. http://jiscg3.blogspot.com/

Dr Patrick Weber is a postdoc researcher /teaching fellow and geo-application developer consultant with 8 years experience in GIS, spatial analysis research and product development. He is a geography graduate with an MSc in GIS from UCL, and was awarded an Engineering Doctorate sponsored by the LDA's FDI investment promotion body in 2010. His research is looking at FDI business site selection in London. Apart from his knowledge in the analysis and support of business location decision making, and user requirements specification using Personas and AGILE approaches, Patrick has extensive experience in the creation and delivery of GIS projects. He is the application developer on the #JISCG3 / IIGLU project.

Dr Claire Ellul is a Lecturer in Geographical Information Science (GIS) at University College London. Having graduated in Electrical Engineering, she worked for ten years internationally as a GIS, specialising in systems architecture design, data management, programming and integration of GIS software. Claire completed a PhD in GIS at UCL in 3D topology and worked as a post-doctoral researcher at UCL and London Metropolitan University. She designed and programmed the Mapping for Change software and now lectures on the MSc in GIS course, with specific responsibility for the *Spatial Structures and Representations* and *Databases and Spatial Databases* modules.