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THE E-MAPSCHOLAR PROJECT – AN EXAMPLE OF INTEROPERABILITY IN GISCIENCE EDUCATION

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1. INTRODUCTION

The explosion in the use and availability of spatial data affords challenges and opportunities for educators. In the UK, Higher Education Institutes (HEIs) have negotiated through the JISC (Joint Information Services Committee) access to electronic data from the Ordnance Survey. These data are available to students at subscribing institutions through the EDINA Digimap service, for which more than 75 UK HEIs have now signed up [1]. The Digimap service essentially provides three routes to spatial data – in the first a simple client receives tightly constrained but cartographically sensible data from the server in the form of map images. The user can control features and zoom in and out, but the appropriateness of display at particular scales is controlled by the server. The second mode of use allows the user to select data from different data sets to form maps in a Java applet, with the only constraints being imposed by service considerations (for instance it is not possible to create a map of whole of the UK using 1:10 000 data as a source). The final mode of use of the service allows the user to download raw data as provided by the Ordnance Survey for use in analytical tasks often involving a GIS.

Users of the Digimap service come from a wide range of disciplinary backgrounds, many with a limited tradition of either the application of, or teaching about spatial data [2]. An area of concern was how to bridge the skills and knowledge gap that would exist in users new to digital map data in order that they could most effectively use such data.

The e-MapScholar project is a response to this concern and aims to deliver teaching materials that promote the use of geo-spatial data in learning and teaching, thus growing the market in the use of spatial data. The project seeks to support learners through the provision of a range of materials that develop skills in the use of digital map data and knowledge of geo-spatial concepts specific to a variety of disciplinary backgrounds – not just the geosciences. The aim of the project is not to teach students about GIS functionality, but rather about key concepts in utilising spatial data with examples contextually relevant to their discipline.

The development of the e-MapScholar project addresses key issues in the provision of educationally interoperable teaching materials and the application of functional interoperability in the provision of such teaching materials. In describing the project we ask three key questions about interoperability in education:

- What is interoperability in GIScience education?
- Why is interoperability in GIScience education required?
- How can interoperability be facilitated in GIScience education?

2. WHAT IS INTEROPERABILITY IN GISCIENCE EDUCATION?

A brief examination of the literature reveals that there are many competing definitions of interoperability from the technical to the conceptual. However, Wiederhold [3] suggests that the objective of interoperability is "to increase the value of information when information from multiple sources is accessed, related and combined."(pp. 1)

Včkovski [4], in setting out a definition of interoperability argues that by examining both technical and non-technical examples of interoperability it is clear that a key issue in achieving interoperability is defining a contract with agreed common features. In GIScience, perhaps the most familiar example of interoperability at a technical level is provided by OpenGIS (OGIS) specifications for interfaces allowing data to be shared between applications – for example the Web Mapping Server specification (www.opengis.org). At a higher and more abstract level, interoperability is facilitated by the use of metadata – for example the IMS (Instructional Management Systems) metadata standards [5] which seek to specify metadata describing not only educational content, but also context through discipline specific schemas. By applying such metadata, at least in principle, educational content can be shared between organisations.

The term educational interoperability has at its core the concept of sharing materials, and is defined by Kemp et al. [6] to imply that one can create "materials which are shareable and can have multiple uses in various contexts" (pp 103). They argue that both concepts and data must be localised in providing interoperable learning materials, and in turn such localisation requires a set of definitions or contracts between potential users of the materials.

3. WHY INTEROPERABILITY IN GISCIENCE EDUCATION?

A key question before undertaking a project to provide interoperability in education is why? It is clear that significant overheads are added to the development of any project in developing metadata specifications that are both broad enough to allow a wide range of usage and specific enough to facilitate functional interoperability between components of the learning resources. Developing materials which are suitable for adaptation to use in other contexts implies a significant overhead on the already hard-pressed academic's time in completing the necessary metadata and providing materials which focus on concept-rich examples where contexts are interchangeable. How can people be persuaded to develop such materials?

It is clear that educators in GIScience are to some extent persuaded of the opportunities afforded by a pooling of resources and development of national core curricula in GIS. The creation of the UNIGIS consortium (www.unigis.org) which delivers distance learning GIS courses internationally is an example of the former, whilst the development of materials such as the NCGIA core curricula (www.ncgia.ucsb.edu/giscc/) is an example of the latter. However, these materials are interoperable only in the sense that they are intended to provide a resource providing assistance in developing course content for lecturers – they are not designed to be with localisation in context or space in mind, but rather to give sufficiently broad brush examples to satisfy a general audience. The materials provide a valuable, credible and free resource of static materials which can be inserted into teaching materials with minimal effort.

Functional interoperability and developing technologies in GIScience provide us with opportunities to innovate in the provision of learning and teaching materials. Web-based learning is most popular with students when some level of interaction is provided [7], but to be most effective these interactive examples should be context specific. This in turn implies that for different disciplinary backgrounds examples should be 'localised' – for example tailored to geographical regions or contextual backgrounds that form part of a student's learning. Interoperability in GIScience education provides a framework under which this can be achieved.

4. HOW CAN INTEROPERABILITY BE FACILITATED IN GISCIENCE EDUCATION?

Central to the e-MapScholar project is the provision of teaching and learning materials which facilitate use in a range of disciplinary contexts. The materials have as an underlying theme the use of spatial data, and specifically those data provided by the Digimap service. However, the concepts of using spatial data are broadly independent of the particular data source, which should rather be viewed as providing a context for examples. Through consultations with teaching staff, three main areas were identified as key conceptual interdisciplinary domains for the e-MapScholar project:

- *Working with digital map data*;
- *Data integration*; and
- *Data visualisation*.

These domains provide the highest level of granularity in the project, and can be considered as broad themes to which learning materials are attached. Within each theme a set of learning resources was developed, with each resource aimed at providing a coherent set of learning materials. Learning resources themselves consist of a set of learning units, the lowest level of granularity visible to a student. Learning units consist of a set of learning objectives, interactive tools and learning objects illustrating key concepts within the unit and some tools providing formative assessment. Figure 1 illustrates the components making up a learning resource and their relationships.

In themselves such materials are similar to those provided by many other online courses in GIScience and education in general. However, the design of the e-MapScholar project has from the first wholeheartedly embraced the concept of customisation. Through consultation with those interested in using materials it was ascertained at an early stage that customisation for most academics would most fruitfully allow the insertion of local examples in a spatial sense, and the provision of disciplinarily specific examples. It was also suggested that the reassembly of existing learning units to provide new resources would also be a useful facility.

To allow such customisation the design process of the e-MapScholar project had to consider several key issues:

- At what level of granularity should customisation be possible?
- How can materials be provided which allow customisation of both locally and disciplinarily specific examples?
- How could such materials be stored such that they can be accessed and modified without a detailed understanding of the underlying functional interoperability?
- What metadata were necessary to address such issues as lineage and ownership?

Interestingly these issues can be seen to have some considerable overlap with the list of unresolved problems put forward by Kemp et al. [6]. The implementation described here is not the only, or necessarily the best possible solution to these problems but we believe it goes some way to addressing the agenda suggested by Kemp and others.

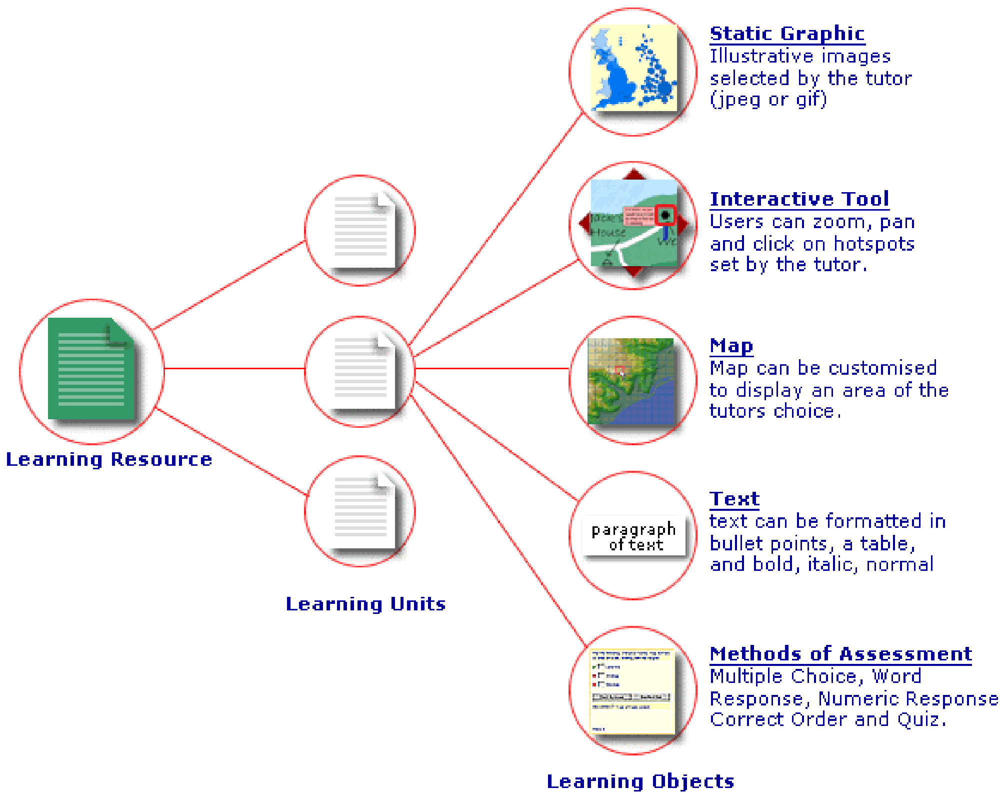

Fig. 1 Components making up a learning resource

4.1 To what level of granularity should customisation be possible?

Customisation can be provided at many different levels, from allowing the user to write materials from scratch to simply allowing users to copy materials to a local space and add some localised introduction or reorder the basic units to form new materials. In the e-MapScholar project customisation is possible at the granularity of learning resources and units. Customising a learning resource essentially involves either a reordering of the learning units, the deletion of particular units, the insertion of different learning units or some combination of the above. As part of the customisation process it is necessary to enter new metadata indicating the learning objectives of the new resource and its intended audience. Lineage information is stored, and the learning units used in the resource are flagged so that customisation at a lower granularity – namely that of the unit does not invalidate the resource.

Customising a learning unit is intended to facilitate the use of the materials among a broad range of disciplines. A unit is made up of a set of learning objects as shown in Figure 1, and any of these objects can be customised. In the case of text, this might involve changing the text, whilst in the case of a map or tool alternative data might be used to illustrate a concept. The assumption is that customisation is mainly necessary to localise the materials but that the concept being illustrated will remain largely the same. It is not possible to completely reorder or delete the learning objects chosen by the original author in illustrating a concept.

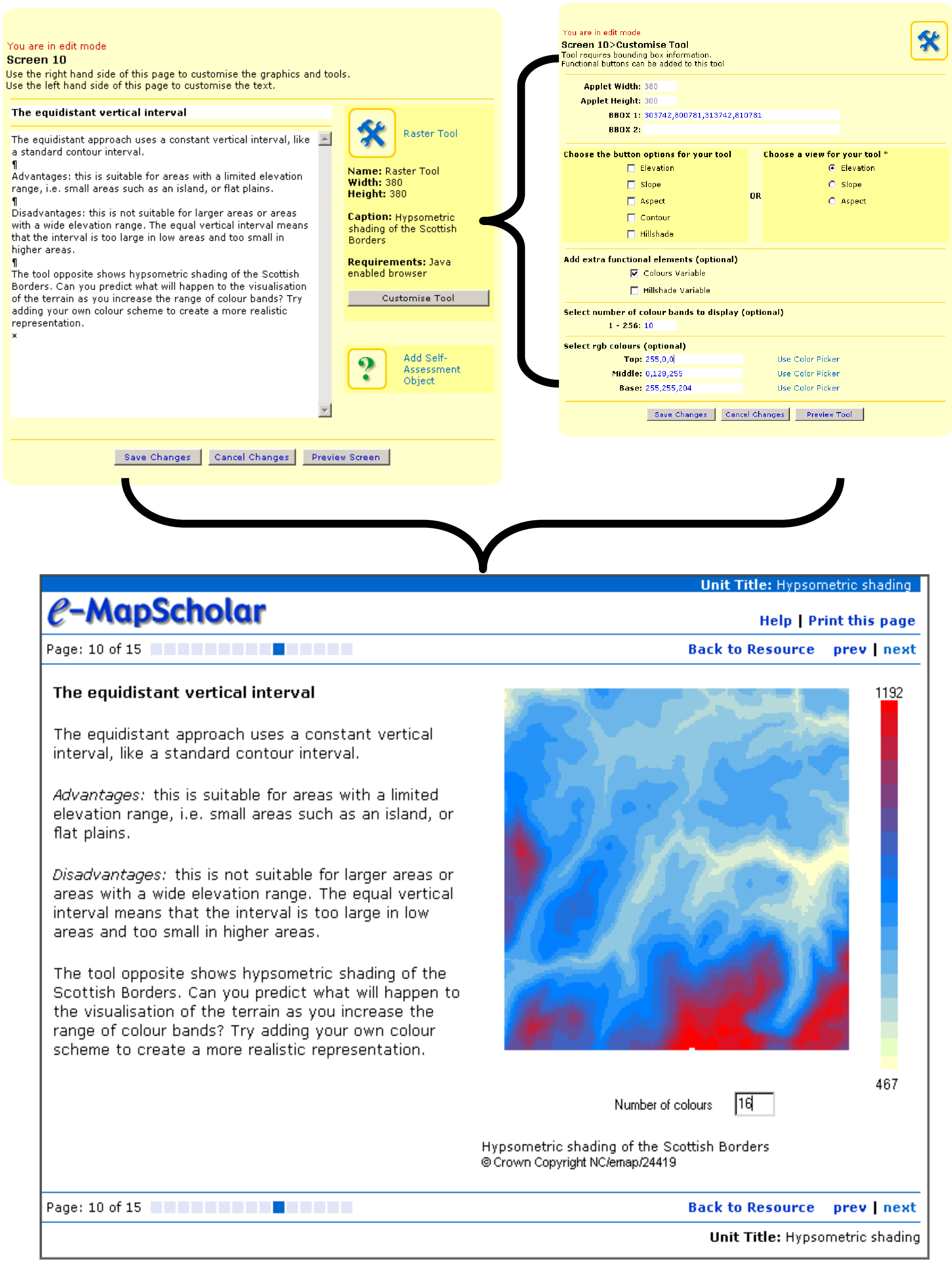

Fig. 2 Screenshots of CMS elements for text and a tool and the resulting page. The tool in this case displays raster data allowing the user to vary the intervals and colours used in the hypsometric shading of the data. The lecturer can choose the area to be visualised, the initial colouring and number of intervals. (The raster tool can also be further customised to display linked views, hillshading, slope, aspect and contours)

4.2 How could materials which allow customisation to locally and disciplinarily specific examples be provided?

The e-MapScholar project is focused around spatial data and as such the key components of customisation involve the provision of tools illustrating the use of spatial data. At the simplest level, all tools can be customised by changing the bounding box of the spatial data. So, for example a lecturer in Wales might use data from Snowdonia to illustrate ideas on hill shading instead of from the Highlands of Scotland. This customisation is made possible by underpinning the tools with OpenGIS web map, feature and coverage servers (www.opengis.org). Thus data are provided to the tools as long as OGIS compliant requests are made. Currently all the data are provided by the Digimap service, but if for instance it was desired to use examples localised to the US, providing OGIS compliant services existed there is no reason why the tools could not use these underlying data to illustrate various concepts, licence issues not withstanding. Figure 2 shows a sample page from a learning unit illustrating a tool and the customisation process for such a tool (described in more detail in § 4.3).

4.3 How could such materials be stored such that they could be accessed and modified without a detailed understanding of the underlying functional interoperability?

Key to encouraging the use of materials and their customisation are user-friendly mechanisms for accessing and modifying materials. In the case of e-MapScholar these data are accessed through the use of a bespoke Content Management System (CMS) which allows users to assemble and edit materials through the use of online forms. In this sense the CMS is a sub-component of a Learning Management System (LMS) itself typically comprised of:

1) An environment that facilitates design and presentation of material;
2) A set of tools supporting learning and collaboration; and
3) A set of administrative tools to assist the instructor in the process of assessment, and overall management of a course.

Within the CMS, users can edit materials through a mixture of text boxes and dialogs (the wizards proposed by Kemp et al. [6]) in order to create learning units and resources without any knowledge of the underlying materials (Figure 2). The materials themselves are stored in XML, for which document type definitions (DTDs) have been defined at the level of the learning resource and the learning unit.

4.4 What metadata were necessary to address such issues as lineage and ownership?

Underpinning the CMS is a large amount of metadata. This is used to describe both learning resources and learning units. The metadata is based upon the IMS Learning Resource Meta-data Information Model [6]. It became clear as the CMS was developed that the IMS standard had certain deficiencies. Key deficiencies were the lack of a definition of the life cycle of a unit or resource, and secondly a way of recording the lineage of the units as they were re-used. Related to this was the issue of ownership of the intellectual property rights (IPR) of units. A CMS Metadata Model for both resources and units was defined based on the IMS standard but extended to take account of the life-cycle of a learning resource and unit. The original author and current author are recorded as part of the metadata of any documents. The author history is maintained by a registry. This can be used to describe the ancestry of all documents in the system. Thus for any unit or resource, a list of previous authors can be generated.

5. SUMMARY

This paper describes the e-MapScholar project which aims to provide interoperable learning materials relevant to spatial data sets available to UK HEIs. The paper describes the functional and conceptual interoperability provided by the project through the provision of:

- metadata allowing materials to be shared and reused which include concepts such as lineage; and
- functional tools allowing academics to quickly and easily localise materials to appropriate geographical and contextual examples whilst retaining the broad concepts underlying the materials.

A content-management system has been developed which addresses both these ideas and allows easy customisation of interactive tools – a key component of successful e-learning materials. It is therefore suggested that the project makes a contribution towards addressing the agenda proposed by Kemp et al. [6] for facilitating interoperability in GIScience education.

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