CONCEPTIONS OF GEOSPATIAL INFORMATION IN ONLINE DISTANCE LEARNING GIS PROGRAMS

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ABSTRACT
This article describes conceptions of geospatial information (GI) as they are perceived amongst Geographic Information System/Science (GIS) academics and students in three GIS online distance learning (ODL) programmes in the UK and US, through an embedded exploratory multiple case study. We highlight the user input element of GI that emerged in the conceptions of GI. Using this element, we uncover competencies and knowledge learners need to be able to interact with, and use, GI in technology-oriented disciplines such as GIS.

KEYWORDS
Geospatial information conceptions/ Three or four-dimensional information/ Geographic Information System/Science (GIS)/ Online distance learning/ Information literacy/ exploratory case study

1. BACKGROUND OF STUDY.

This article focuses on the conceptions of geospatial information (GI) from the perspectives of academics and students who are teaching and learning GIS in three Online Distance Learning (ODL) programs across the UK and US.

Exploring the perceptions of people who have real learning and teaching experiences of information within specific disciplinary areas has been identified as an appropriate approach to identify Information Literacy (IL) educational needs (Webber et al. 2005; Boon et al. 2007; Bruce 1997). IL competencies enable individuals ‘to recognise when they need information, to determine their information needs, and to find, evaluate, and use information effectively’. Owing to its power in enabling people to ‘learn how to learn’ and become ‘lifelong learners’, IL has been identified as ‘a survival skill in the information age’ (Association of College and Research Libraries (ACRL), 1989).

IL can be seen as central to higher education, particularly in ODL programs that require learners to be able to interact with, and use, various types of information and communication technologies to perform as e-learners, and accomplish their learning tasks successfully. More broadly, it can help them experience learning independently with having less, or no, face to face contact with their instructor or peers. This need for IL and ‘learning how to learn’ even increases when the target ODL courses are technology-oriented courses such as those in GIS. GIS courses require learners to understand and use three or four-dimensional information and use spatially and non-spatially enabled technologies to interact with, and use information in order to accomplish their tasks.

Despite emerging awareness of the key role of people who have direct educational experiences of using information, e.g. students, for investigating real information and IL educational needs in disciplinary areas, librarians have been the main developers of key IL models and practices (Webber et al. 2005; Webber and Johnston 2000; Boon et al. 2007; Bruce 1997). This includes the main models and frameworks of IL such as ACRL and the Big6 (ACRL 2000, Eisenberg and Berkowitz 2000).
Likewise, the majority of IL programmes have been developed by librarians and information professionals (ACRL 2007). They have been ‘written by librarians for librarians’ with ‘the assumption that librarians play the key educational role’ (McGuiness 2003). This is mainly because these models have not been based upon an understanding of specific disciplines and the nature of information and IL needs within the disciplines. Indeed, this requires in-depth investigations of the perceptions and experiences of people who are directly interacting with, and using information to accomplish various real-life educational tasks.

There are a few studies on the academics’ perception and experience of IL education that, to some extent, contribute to this area of research. These include phenomenographic studies of the conceptions of IL of British faculty in four disciplines (Webber et al. 2005; Boon et al. 2007), Australian university educators (Bruce 1997) and Irish academics (McGuiness 2003), and a Canadian survey of information amongst science and engineering faculty (Leckie and Fullerton 1999). Thus exploring the concept of information and IL in the spatially technology-oriented discipline of GIS is a novel area. However, a need to develop information literate GIS professionals has been identified (Joint Information Systems Committee (JISC) 2007; Johnson 2001; Jablonski 2004; Massey 2002).

Apart from literature on the conceptual aspects of GI, there are few studies that have attempted fill this gap, using existing models of IL developed by librarians (Jablonski 2004; Massey 2002). Jablonski (2004) recommends the ‘Big6 information problem-solving model’ as a basis for developing the learning objectives of the GIS course to increase undergraduate GIS students’ ability to accomplish their assignments or project independently. Although this approach attempts to put GIS faculty in charge of teaching IL; the component of the model they are recommended to use is not based on their understanding and experience of the GIS learners’ information and educational needs.

Massey (2002) describes collaborative projects in the GIS field (Xgrain, e-MapScholar, and EDINA) funded by the UK’s JISC. These projects aimed at providing undergraduate and graduate GIS students with different training and learning materials to help them with finding, evaluating, and research skills, as ever more imperative skills. Insofar as they addressed IL, they drew on the seven pillars of information literacy model developed by the Society for College, National and University Libraries (SCONUL, 1999) targeting the UK higher education generally.

Thus this current study addresses the research gap. In the next section we describe the aims and approach of the whole study, and explain in more depth the part of the study (investigating conceptions of GI in an ODL environment) that is the focus of this paper.

2. METHODOLOGICAL APPROACH.

Case study is an ‘ideal’ methodology when ‘a holistic, in-depth investigation is needed’ (Yin 2003) to gain deep understanding about a phenomenon or few issues in real-life contexts (Eisenhardt 1989; Stake 1978; Yin 2003; Dooley 2004; Denscombe 2003, 38). Particularly, it is suitable for exploring a complex phenomenon and relationships between its ‘attributes’ (Kennedy 1979).

Goodchild (1997) characterised GI as ‘information about places on the Earth’s surface’, ‘knowledge about where something is’, and ‘knowledge about what is at a given location’. GI can be ‘often relatively static’, ‘very voluminous’, and ‘expressed in digital form’ that like ‘many kinds of information can be handled by the same technology’. Such characteristics make GI a complex phenomenon. To explore the complexity of GI in the various ways it is used and experienced, an embedded exploratory case study design was adopted (Yin 2003). This design permits holistic exploration of phenomena in real-life contexts, and it helps to illuminate and understand the phenomenon better (Yin 2003, 43). The following paragraphs focus on the methods used to carry out the part of study that this paper concentrates on.

Due to the exploratory nature of this study, inductive methods including in-depth face-to-face interviews were employed to explore GIS academics and students perceptions’ concerning the nature and characteristics of GI in the context of their learning and teaching experiences of several ODL GIS courses. The study sites comprise partners in an online distance learning (ODL) Masters degree GIS programme collaboratively delivered by Universities of Leeds, Southampton, in the UK, and Penn State University, in the US. This partnership programme is part of ODL programmes sponsored by the World Universities Network (WUN), Global GIS Academy and delivered in a complementary articulation model of e-learning (EL).

The participants in the part of the study described here are the 20 academics who are in charge of designing and delivering 27 courses in different subject areas of GIS, and seven students with various
professional and educational backgrounds and experiences of the GIS courses delivered by the study sites. Students were selected based on their interest in participating in the study and the researcher’s accessibility to them, as they were online distance learners in all over the world.

To explore the phenomenon under study, the participants were interviewed and asked to share their thoughts and experiences of GI by answering two main questions:

- How would you describe GI and what makes it unique?
- How would you describe the physical format of GI?

Interviewing is ‘a powerful way to gain insight into educational issues through understanding the experience of individuals whose lives constitute education’ (Denscombe 2003, 164). It also ‘provides access to the context of people’s behaviour and thereby provides a way for researchers to understand the meaning of that behaviour’ (Seidman 1998, 4). The interviews were fully transcribed and analysed, using Grounded Theory data analysis procedure including coding data, memo writing, and writing theory (Mansourian 2006). Simultaneous data collection and analysis, constant comparative analysis, and ‘conceptualising and interplaying with data’ are distinctive features of grounded theory data analysis method that provide a strong foundation for constructing a valid theory, emerged from the data (Glaser and Strauss 1967).

Using these features, the process of data analysis was started after transcribing the first interview. The researchers coded each transcription in as many as categories or meanings and wrote their interpretation of each category. This ‘memo writing’ helped to ‘conceptualise and gain analytical perspectives about the data (Strauss&Corbin 1998) and establish a foundation for the framework of GI conceptions.

Indeed, simultaneous data collection and analysis helps to compare ‘each item of data’ with ‘every other item of data’ and to identify ‘many conceptual relationships’ within the ‘context of descriptive and conceptual writing’ and to ‘sort and delimit the theory’ (Cutcliffe 2000, 1477). Constant comparisons of current categories of concepts with data from the next interviews, on the other hand, helped to enrich or expand the foundation by creating new categories or adding subcategories to the current ones.

To outline the core conceptions of GI, the written memos were sorted, i.e. connections between the memos were identified through ‘conceptualising and interplaying with the data’ and the similar categories were integrated into one. Ultimately, the ‘write-up of ideas’ and the integrated categories of concepts were ‘theorised’ and formed a framework of four main conceptions of GI, described in the following section.

To anonymise the data, participants’ names were replaced with the following abbreviations identifying the interviewee’s role (academic or student) and the study site at which s/he experienced GI. To identify reference to an exact quotation, numbers from 1 to n are used after each code. For example, to determine a quotation from paragraph 10 of an interview transcript belong to academic number 6 in Leeds, the reference for the quotation will be 6AL-10.

<table>
<thead>
<tr>
<th>Academics</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leeds</td>
<td>Southampton</td>
</tr>
<tr>
<td>1AL-7AL</td>
<td>1AS-2AS</td>
</tr>
</tbody>
</table>

3. CONCEPTIONS OF GEOSPATIAL INFORMATION (GI).

This section describes four conceptions of GI as it was perceived and described by the GIS academics and students in three ODL GIS Masters programmes in the UK and US. Altogether four main characteristics highlights in the conceptions that distinguishes GI from information in other disciplines. These are spatial, temporal, spatially technology-mediated, and spatially contextualised conceptions.

3.1 Conception One: Spatial

The key characteristic of this conception is that GI is seen as information or data that has a location element associated with it, or data that has a geographic or non-geographic location. In this conception, GI has been described as a type of data that ‘has a spatial component’ (6AL-20, 2SL-10, 5AP-5, 2AP-23, 8AP-52) or ‘some location’ (2SL-37) associated with it.

There is a general agreement that ‘location’ associated to GI is the feature that distinguishes GI from information in other disciplines. According to 5AP-6, GI is ‘associated to a location whereas other subjects


[disciplines] maybe associated to a subject or other things than location’. To highlight the importance of the location element of GI, there are several statements that identify subject of GI; ‘geography’ or ‘location’ (5AP-6, 6AL-20), using the term ‘geographic data’ (8AP-90).

Although in the majority of GI concepts the ‘location’ element has been specified as a geographic location (2AS-4, 3AL-6), there are few statements which do not consider this component ‘necessarily related to the earth and geography; anything on the space can have a spatial component’ (9AP-34). For example, in disciplines such as Molecular biology or Medicine, the data can be diagrams or pictures of different parts of body, organs, or molecular (8AP-66) which are not necessarily geographically relevant to the earth surface. However, the location of different parts of body in relation to each other can make the data GI.

Similarly, there are some descriptions of GI that identify it as an abstract concept of the earth features. For example, 8AP-109 describes GI as ‘an abstract representation of the features on the earth in defined boundaries’ and 3AL-6 identifies it as ‘abstract of things with a location on the earth’. Likewise, 1AP-2/1 perceives GI as ‘representative of the earth features’ and 9AP-34 calls GI ‘anything on the earth surface [that] can have a spatial component’.

3.2 Conception Two: Temporal

GI is seen as a temporal phenomenon as it is about a dynamic phenomenon i.e. the earth. In other words, GI is data or information that represents a phenomenon in certain point(s) of time. 8AP-110 identifies GI as type of data that ‘has a spatial component; where the thing is being described’. This ‘where’ has been identified as ‘the earth’ in several concepts of GI (8AP-109, 3AL-6, 1AP-2/1) which is ‘dynamic’ (1AP-2/1, 3SL-9, 45) and ‘temporal’ in its nature (11AP-24, 2AS-5). In other words, GI, as ‘four-dimensional information’, with the time element as the fourth dimension, is a temporal entity. Indeed, to understand information with such characteristics, there is a need to conceptualise these components (11AP-24, 2AS-5):

‘It [GI] is conceptualised by being temporal in its nature as well as spatial (11AP-24).

3.3 Conception Three: Spatially Technology-Mediated

GI is seen as any type of data that is readable and usable by GIS. From this perspective, GI needs to be mediated by spatially and non-spatially enabled technologies and tools. At the heart of this conception lies the importance of GIS for making sense of, and, use of GI. This has been highlighted in the conceptions that identify GI as data or information that need to be formed and transformed using GIS or using other non-spatially enabled applications such as spreadsheets, word processing, etc.

The mediation can take various forms including, capturing, gathering, creating, manipulating, mapping, organizing, analysing, displaying, handling, presenting, and using GI. According to 4AL-5, ‘there is no GI but data that GIS can be handled’. GI also has been identified as type of data that ‘can be computerised’ (8AP-52), ‘mapped’ (2AP-25), ‘presented and processed in MapInfo’ (3SL-9, 6), and ‘can be analysed with GIS … to present all the complexity of all the features of the earth’ (1AP-2/1).

This particularly can be explored in the participants’ conceptions of GIS that see GI and GIS inseparable components of GI concept. This particularly can be illuminated in the perceptions that identify the very nature of GIS ‘to do with having spatial information on computers and using that to analyze spatial patterns’ or more broadly ‘to do with maps on computers’ (1SL-1).

More holistically, 4AL-3 sees GIS as ‘a package solution, a set of standard techniques … a four stage process’. 4AL-4 uses a retail task as an example to demonstrate how GIS needs to be involved to mediate GI:

a) To get information about customers and their characteristics – GIS as a capture, geo-coding tool.
b) To get information about customers from the census data – GIS as a manipulation tool.
c) To use census data to see where the customers live – GIS as spatial analysis tool.
d) To map the data or to produce maps from the data – GIS as a mapping tool.

Perceptions of GI that highlight tangible aspect of GI were also explored to illuminate the ‘spatially technology-mediated’ conception of GI and ways in which GI needs to be mediated by technology. This includes attributes associated to the GI, or more precisely to the ‘location’ element of GI, and physical format of GI. In both areas mediation is needed to form and transform information or data to GI; or to make sense of, and use of GI.
3.4 Conception Four: Spatially Contextualised

The key characteristic of this conception is that GI is seen as a dynamic phenomenon, socially and geographically constructed, which needs to be spatially conceptualised and contextualised. According to 11AP-24, ‘most of geographical information is contextualised in our life, it’s not really absolute; there is a context that gives it a grounding meaning’. He identifies ‘social’ and ‘geographical’ contexts where such meaning would emerge (11AP-24).

In the field of GIS, it is not easy to formulate information concept without contextualizing it, and therefore it is not easy to ‘encode information and understand it really and correctly’ (11AP-24). In this regard, 11AP-24 believes that ‘geographic data are socially constructed, for almost all part’:

‘We can talk about original maps that encode original property around the city; that’s the socially constructed thing, it doesn’t exist in nature. We can talk about a forest and I would argue that is socially constructed thing too. You call forest depending on, very much, where on the earth you are, there is no universal forest. It’s helping people to construct [meaning or concepts], to communicate’.

2AS-5 identifies this as distinctive feature of ‘spatial and temporal’ information used by ‘GIS scientists or geographers’ which make it challenging, in contrast to information used by ‘social and physical’ scientists.

4. DISCUSSION.

These GI conceptions imply that to make sense of, and use of, GI there is a need for some ‘user input’ that varies in each conception. The diversity in the ways of formation and transformation of GI requires various types of user input including spatial thinking, spatially mediating or operating GI, and spatially contextualising and applying it, as outlined in Table 1. The type of ‘user input’ may vary depending on the task or purpose of using GI. For example, looking at the first conception of GI, spatial thinking may require the user to be able to visualise GI in his mind or to be able to make it understandable by spatially-enabled technologies e.g. GIS. This is also the case for spatially mediating or operating GI (third conception). For example if a user intends to make GI usable by GIS there is a need for certain manipulations; whereas if s/he wants to use GI s/he need to handle and analyse it, which would require different types of user input in terms of his or her ability in selecting and using appropriate technologies and tools.

Similarly, in the ‘spatial contextualising and applying GI’, the ‘user input’ may appear in the form of conceptualising GI spatially as a socially and geographically constructed phenomenon, integrating his or her personal value system and knowledge base, or applying GI in real-life problems to make plans or decisions. Table 1 identifies key elements in terms of the appearance of GI, the user input and the required knowledge and competencies which emerge from the conceptions of GI. The latter are elaborated further below.

Table 1. Form of ‘user input’ and needed competencies in the ways that GI was perceived

<table>
<thead>
<tr>
<th>Conception</th>
<th>Appearance of GI</th>
<th>User input</th>
<th>Competencies required to:</th>
</tr>
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<tbody>
<tr>
<td>One</td>
<td>Objective- spatial in its nature with a location associated to it; need certain way of thinking or visualizing to understand it</td>
<td>to be perceived spatially</td>
<td>to make sense of GI as three-dimensional information</td>
</tr>
<tr>
<td>Two</td>
<td>Objective – temporal in its nature, about dynamic phenomenon; need certain way of thinking or visualizing to understand it</td>
<td>to be perceived spatially and temporally</td>
<td>to make sense of GI as four-dimensional information</td>
</tr>
<tr>
<td>Three</td>
<td>Objective – spatially technology-mediated Need to be mediated outside of the user’s mind; need spatially and non-spatially enabled technologies to make sense of, and use of it</td>
<td>to be formed and transformed using spatially and non-spatially enabled technologies and tools</td>
<td>to make sense of, and use of GI to form and transform GI</td>
</tr>
<tr>
<td>Four</td>
<td>Subjective - spatially contextualized As part of individual reflection that include his/her personal knowledge base and value system</td>
<td>to be perceived as socially and geographically constructed information and to be contextualized spatially</td>
<td>to apply spatially contextualized GI</td>
</tr>
</tbody>
</table>
In conception one; GI is seen as information or data that has a location element associated with it, or data that has a geographic or non-geographic location. It requires user to have a ‘spatial way of viewing or perceiving’ GI. This may appear in the form of visualising, representing, or conceptualising time and location elements of the GI and thus require various types of knowledge and competencies such as:

- Ability to perceive and visualise information spatially, that may require knowledge of the nature and characteristics of GI;
- Ability to conceptualize GI and its components;
- Ability to represent an abstraction of some of the earth feature spatially;
- Knowledge of the way that GI can be perceived spatially by spatially and non-spatially enabled technologies and tools;
- Ability to use GIS to represent the association of the GI attributes to the location;

In conception two; GI is seen as a temporal phenomenon as it is about a dynamic phenomenon i.e. the earth. In other words, GI is data or information that represents a phenomenon in certain point(s) of time. The user input in this conception would be perceiving GI as a dynamic phenomenon that needs to be kept up-to-date. This would include the object i.e. a particular location on the earth and its attributes, and subject i.e. the phenomenon is studied in that particular place of GI, since in case of any change in the location it may impact on the whole product or output as result of using GI. In particular, the following competencies may be needed to help users contribute effectively to understanding and using GI:

- Knowledge of the ‘time’ component of GI;
- Ability to perceive GI as a temporal or dynamic phenomenon;
- Ability to maintain GI, its product, and the process of using GI;

In conception three, GI is seen as any type of data that is readable and usable by GIS. From this perspective, GI needs to be mediated by spatially and non-spatially enabled technologies and tools. GI is seen objectively as part of the external environment that needs to be formed and transformed using these technologies and tools. The user input may include various operations to make sense of, and use of GI, depending on the purpose, and way of using GI. This mainly includes capturing, creating, manipulating, analysing, mapping, organising, handling, presenting, communicating, and using GI to make plans and decisions. Due to the diversity in the user’s input, it may require wide range of competencies such as knowledge of the GIS capabilities and ability to:

- translate or convert the time and location elements in a language understandable by spatially and non-spatially enabled technologies and tools;
- delineate the attributes of GI to the location using spatially and non-spatially enabled technologies and tools;
- use GIS tools and capabilities as spatially enabled technology to capture or create GI;
- select and use appropriate GIS tools and capabilities as spatially enabled technology to manipulate GI for a certain purpose;
- select and use appropriate non-spatially enabled tools to pre-process data so that it can be readable and usable by GI;
- select and use appropriate GIS tools/ capabilities to analyse, organise, present etc. GI and make decisions and plans.

In conception four, GI is seen as dynamic phenomenon, socially and geographically constructed, that is, including its time, location. In this perception, GI is perceived as internal to individual, or as part of users’ value system and knowledge base, that need to be spatially conceptualised and contextualised in order to be applied for different purposes.

The user input is ‘conceptualising and contextualising information spatially’, including geographical and social contexts of GI in certain point(s) of time. However it involves the user’s knowledge base and ‘value system’ as location and time element can be translated based on the user’s cultural background of certain concepts. As highlighted above by 11AP-24, the concept of ‘forest’ may vary for people living in different places. We contend that this implies that GI as output of users’ conceptualization and contextualisation is a variable of people’s background that, indeed, forms their knowledge base and value system. From this point of view, GI can be seen as part of personal reflection of people’s value system (culture, background) and knowledge base. To establish such user input, following knowledge and competencies may be needed:

- Ability to perceive GI as three/four-dimensional information that is socially and geographically constructed;
- Contextual knowledge of the subject of GI;
- Contextual knowledge of the object of GI;
- Ability to encode and understand information spatially;
- Ability to contextualize GI spatially, using personal knowledge base and value system;
- Ability to integrate personal knowledge base and value system to apply GI for various purposes.

5. CONCLUSION.

Although ‘sustainable higher education’ and ‘maintaining’ GIS curriculum have been, and are, issues (topics) of interest of GIS scholars and educators’ communities, developing a GIS curriculum that responds to the diversity and ever-changing educational needs in this discipline has remained a dilemma (ESRI 2002). This is mainly because of the diversity in ‘GIS background and skills of students’ (Unwin 1997) and speed in the emergence of new technological advancements in this field (ESRI 2002; Libarkin et al. 2003; JISC 2007).

This dilemma becomes even more complicated in the GIS ODL programs that requires students to learn with technology (spatially and non-spatially enabled technologies and tools), about a technology-oriented discipline (i.e. GIS) with the characteristics of information that have already been mentioned, and in a technological learning environment (i.e. ODL).

The attempts to respond to the growing skill-needs of students in GIS programs, and other ODL programs in general, mainly focus on expanding the scope of the curriculum by adding new courses or integrating new topics into existing courses (e.g. in GIS: Nicholson and Ruus 2006, Jablonski 2004; Massey 2002; e.g. in ODL programs in general: Ashmore and Grogg 2005; Hadengue 2004; Getty et al. 2000; Dupuis 1998).

The variation in the ways of perceiving GI achieved from this study calls for an approach which enables learners to diagnose their information and learning needs. The authors propose that the GIS curriculum could be enhanced by integrating development and support of the knowledge and competencies, as identified above, explicitly into courses. This would include making students aware of the required user inputs and learn how to interact with and use GI more effectively within a technological environment.

In terms of information literacy within GIS education, this means moving from a generic approach (as exemplified by Big6 or ACRL standards) to a specialised framework which meets the specific needs of GIS learners. This would enable learners to identify their information and learning needs by thinking and questioning critically.

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REFERENCES


Please refer to: