What Do the Conceptions of Geo/Spatial Information Tell Us About Information Literacy?

Maryam Nazari

Iranian Research Institute for Information Science and Technology (IranDoc)

Tehran, Iran

maryamnaazri76@gmail.com

Sheila Webber

Department of Information Studies, University of Sheffield, UK

s.webber@sheffield.ac.uk

Abstract

Purpose – This paper reports findings from an investigation into the conceptions and characteristics of geo/spatial information (GI) to demonstrate how exploring academics and students' conceptions of GI facilitated illumination of information literacy (IL) in the Geographic Information Science/Systems (GIS) discipline.

Design/methodology/approach – Adopting an embedded exploratory case study, the data was gathered from semi-structured interviews, an open-ended questionnaire and students' reflection in an online distance learning (ODL) Geographic Information Science/System (GIS) programme. The data was analysed in light of Grounded Theory approach. Drawing on the conceptions of geo/spatial information (GI) which emerged from the study, this article highlights several characteristics of GI and discusses their implications for IL. In particular, it compares the emergent IL competencies in the GIS discipline with the ones in the SCONUL model.

Findings –GI was identified as a) geo/spatial; b) temporal; c) geo/spatially contextualised; and d) geo/spatially technology-mediated. According to these conceptions, GI is a constructive concept, it has multiple components which need various operations and user inputs to become geo/spatially meaningful and usable. These characteristics uncovered new aspects of IL in the GIS discipline which influence the depth and breadth of the SCONUL model.

Research limitations/implications – Unlike exploratory studies of IL which focus on the IL and IL competencies to explore this phenomenon, the methodological approach taken in this study provides IL researchers with a new approach whose primary focus is on the concept of information as a key contextual element of IL. This helps to gain a deeper insight into IL in disciplinary areas.

Practical implications – The emergent aspects to the SCONUL model can be taken into consideration when designing and delivering IL programmes in the GIS discipline. Likewise, the emergent picture of IL in this study can be used by GIS educators to develop information literate GIS learners.

Originality/value – This study is original both in terms of its methodological approach and outcomes. These can be of value to IL researchers, educators and practitioners.

Keywords Geospatial information, Three or four dimensional information, Information literacy, Geographic Information System/ Science (GIS) discipline, Online distance learning/ exploratory case study

Paper type Research paper

1. Statement of the Problem

Information literacy (IL) has been defined as "knowing when and why you need information, where to find it, and how to evaluate, use and communicate it in an ethical manner" (CILIP, 2006). Bawden (2001) traces the history of the term and positions it in relationship to other literacies. More recently there has been an increase in the number of research studies exploring the meaning of information literacy. According to exploratory studies of IL, IL means different in different disciplines and contexts, notably because the concept of information itself varies in different disciplines and contexts (Lloyd, 2005; Webber et al., 2005; Leckie and Fullerton, 1999; Wu and Kendall, 2006). Talja and Maula (2003) identify disciplinary differences in use of e-journals, and note that studies in information behaviour have identified variations by subject domain. Concentrating on the workplace, Lloyd (2009) emphasises that IL is developed through activities which are situated in a person's sector of work.

In their phenomenographic study of the conceptions of IL in four disciplines, Webber et al. (2005) identify IL as a phenomenon that is defined in the context of people's meaning of information and internal and external factors (e.g. the nature of learning tasks and employment expectations) informed by the nature of disciplines.

In the English discipline, for example, one of the conceptions focuses on information as "text" mainly in the form of books that requires students having "library skills" or "bibliographic skills", often engaging with information in a physical library. However, in the Marketing discipline, information has been identified taking a number of forms (e.g. "news, market reports, journals, numerical datasets, company websites, people and organisations, including observation of people in real-life situations" (Webber et al, 2005: 12) and there is a tendency towards using online access rather than physical libraries. In the Marketing there is a focus on the "real world" as a core in some of the IL conceptions. This reflects the nature of disciplinary requirements, that is, the need to use real world information sources, to be able to solve problems in a marketing career and perform as a confident practitioner (Webber et al., 2005: 12). In contrast, in the English discipline, there is a focus on “personal development as a critical being, in the academic world, or in social context” (p.13).

Thus, to define IL for disciplinary areas there is a need to explore the meaning of information and IL in the context of these disciplines.

Recent exploratory studies of IL have tended to focus on the people’s conceptions and experiences of IL to explore this phenomenon (e.g. Lupton, 2008; Webber et al., 2005; Bruce, 1997). Although such studies provide in-depth views of IL and uncover the variation that emerges from people’s different experiences and conceptions of IL, they do not explore the broader context of IL within which IL is defined. Due to the importance of the concept of information in understanding the disciplinary and educational contexts of IL (Nazari, 2010), this study aims to explore conceptions of information in the Geographic Information Science/Systems (GIS) discipline and discuss their implications for IL.

The nature of IL in the GIS discipline has not been the subject of research. Like many other disciplines, attempts to adopt IL in the GIS discipline tend to rely on the existing models of IL such as SCONUL (1999), the IL model developed for Higher Education in the UK, and Big6 (Jablonski 2004; Massey 2002), rather than exploring IL in the context of the discipline. Jablonski (2004) recommends the ‘Big6 information problem-solving model’ as a basis for developing the learning objectives of a GIS course to increase undergraduate GIS students’ ability to accomplish their assignments or project independently. Similarly, in collaborative projects in the GIS field (Xgrain, e-MapScholar, and EDINA) funded by the UK’s JISC, Massey (2002) adopts SCONUL (1999) model to provide undergraduate and graduate GIS students with different training and learning materials to assist them find and evaluate information and develop their research skills.

As has been argued by several IL scholars, these models do not present a realistic portrait of IL in different contexts and disciplines, because they have mainly developed based on the librarians’ perspectives and interpretation of what IL means and what are the IL needs of individuals (Webber et al. 2005; Webber and Johnston 2000; Boon et al. 2007; Bruce 1997; Lloyd, 2005), and not based on research of IL in real-life contexts (Nazari, 2010).

2. Methodology

Adopting exploratory case study, this study aims to explore GIS academics and students' conceptions and experiences of information in the context of a set of Masters online distance learning (ODL) GIS programmes offered jointly by the Universities of Southampton and Leeds in the UK, and Pennsylvania State University (Penn State) in the USA. Case study is known as a triangulated research strategy which employs multiple research methods and different types of data sources (Yin, 1994; Eisenhardt, 1989; Stake, 1998; Denscombe, 2003; Pickard, 2007). Eisenhardt's (1989) process of theory building from case study was used as a framework to guide the research. As will be discussed below, this approach facilitated illuminating IL in the context of the GIS discipline.

The analysis reported in this article is of data collected as part of a wider exploratory case study, a doctoral study, carried out by Nazari at the University of Sheffield (Nazari, 2009). In this article we draw on interview data as well as data gathered from an open-ended questionnaire and students' reflections, as described below. These data were explored to answer the following questions:

- How has geo/spatial information (GI) been conceived, experienced or described by GIS academics and students in the ODL GIS programme?
- What are the characteristics of GI?
- What are the implications of the conceptions and characteristics of GI for IL?
- How does IL in the GIS discipline differ from IL as in the SCONUL model?

After describing the design and process of this study, answers to these questions are presented.

The case selection for an embedded design

This study selected a single case (i.e. an ODL GIS partnership programme) containing several units of analysis (i.e. of the GIS courses and tasks that made up the programme) embedded in the case. The embedded design enabled exploration of the conceptions of GI in the context of a wide range of teaching and learning experiences of GIS in the programme. This enhanced validity of the emergent conceptions and ultimate results of the study (Eisenhardt, 1989: 537)

Selection of the key informants

The study selected courses with different orientations or subject areas which were delivered during August 2006-March 2007 when the data was gathered. This included 23 courses; 14 in the UK sites and 9 in the US site (Appendix 1).

Then key informants were selected based their accessibility to the researcher during the course of study. This included 10 (all) academics in the UK sites and 10 (out of 12) academics in the US site. Thus, 91% of the academics were included in the study. In addition, 55 students participated in the study and were approached through different methods as shown in Table 1.

Table 1. Distribution of the study's informants

Informants	Study sites	Methods of data collection	Number of informants
Academics	Leeds	Interview	8
	Southampton		2
	Penn State		10
Students	UK sites	Interview	3
	US site	Interview	4
		Questionnaire	12
		Students' reflection	36

Such considerations provided the researcher with a rich dataset through which a wide range of perspectives were brought to the phenomenon under study. This, accordingly, established a rich foundation for the emergent conceptions (Pickard, 2007; Yin, 2003; Eisenhardt, 1989).

Crafting data collection instruments

To explore the conceptions of GI, three main tools (semi-structured interview, an open-ended questionnaire and students' reflection) were used to gather data from two main sources of evidence (GIS academics and students). The selected data collection tools facilitated the researcher with strong tools appropriate for the condition and aim of the study. The selected tools were suitable for the exploratory nature of the study as they generated qualitative data (Denscombe 2003; Seidman 1998). On the other hand, because the case was an ODL one and therefore the researcher did not have face-to-face access to students, the open-ended questionnaire and students' reflection provided the researcher with alternative tools appropriate for the condition of the study (Eisenhardt, 1989).

Semi-structured interview was used to investigate conceptions and experiences of 20 academics and seven students about GI in the context of a wide range of GIS courses and learning tasks. Although a small number of students were interviewed, diversity in their educational and professional backgrounds (Appendix 2) resulted in rich data. The questionnaire was built upon the results from the interviews. As has been demonstrated in Appendix 3, the respondents of the questionnaire also were from various backgrounds, with different ambitions for learning GIS. In addition, the academics were asked to customise and embed the questions in the students' final projects in a way that encourage them to answer the research questions. This enabled the researcher to bring the perspectives of a broader number of students to the study.

All these three instruments, interview, questionnaire and guided reflections, addressed two open-ended questions which were:

- How do you describe geo/spatial data/ information or GIS data? And what makes it unique?
- How would you describe the physical format of GI?

The participants were asked to share their conceptions and experiences of GI focusing on their teaching and learning experiences of this phenomenon. To answer to this question, the GIS academics were asked to think of a specific course they teach; and students were asked to think of a specific learning task preferably the most advance one e.g. their final project. As a result, a wide range of perspectives on the conceptions of GI emerged from the study, as the study participants described GI in the context of a wide range of GIS courses and tasks.

In addition to 20 academics and seven students who were interviewed, both in the US and UK sites, in the US site overall 12 students out of 150 completed the questionnaire and three academics agreed to embed the question into the students' projects in three courses which altogether resulted in 36 responses.

Data analysis

Due to the qualitative nature of the data in this study, a grounded approach was adopted to analyse the data. Having extracted answers to this part of study from different sources of evidence, four phases, recommended by Glaser and Strauss (1967), were followed to analyse the data: a) the data from each source of evidence was codified in the form of some themes and concepts; b) the researcher added her interpretation to each code in the form of some memos; c) the themes representing similar meaning of GI were grouped in several conceptions; d) finally using evidence for each group of the conceptions a narration for each conception was written.

The data analysis began immediately after conducting the first interview. Simultaneous data collection and analysis enabled the researcher to adjust her approach both in terms of way of addressing the question and adding new tools (i.e. using questionnaire and students' reflection as complementary data collection tools). This also deepened the researcher's insights into the phenomenon under study (Eisenhardt, 1989). Likewise, constant comparisons of data with the emergent themes shaped a robust foundation for the emergent conceptions (Cutcliffe, 2000). In addition, due to the embedded design of the study, the conceptions emerged from different perspectives as they were obtained from a wide range of units of analysis (i.e. teaching and learning experiences of GI). This also facilitated multi-layer of analysis, i.e. within-unit and across-units analysis. In other words, first each unit was explored to identify statement(s) represent conceptions of GI, then the data emerged from different units were explored and compared to do cross-search pattern search. From the across-units analysis then the ultimate conceptions of GI were portrayed, following Eisenhardt's (1989) process.

To anonymise the data, participants' names have been replaced with the following abbreviations identifying the interviewee's role (academic or student). 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. To keep the data fully confidential, "s/he", and not she or he, has been used to refer back to an educator.

Academics	**Students**

Leeds	Southampton	Penn State	Leeds	Southampton	Penn State
1AL-7AL	1AS-2AS	1AP-11AP	1SL-7SL	1SS-7SS	1SP-7SP

To anonymise data from questionnaires, codes PQ1-PQ12 were allocated for the responses. The procedure was applied for the data from students' reflections, and codes R1-R36 were given to the 36 students' responses to the questions.

3. Conceptions of Geo/spatial Information

Overall four conceptions emerged from the data which identified GI as a) geo/spatial; b) temporal; c) geo/spatially-contextualised; and d) geo/spatially technology-mediated (Nazari, 2010a). These conceptions are described below.

3.1 Conception one: geo/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).

PQ-3 describes GI as data with a geographic component. Highlighting the geo/spatial feature of the GI, he distinguishes GI from data in other disciplines as follows:

"The main thing that sets it apart from other kinds of data is that you can place it on a map. Many types of data are descriptive and provide information about a subject, but GIS data must include a geographic component".

Similarly, PQ12 identifies GI as "data that can be defined in part by its specific location in space".

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: geo/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 an 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. Likewise, PQ-6 perceives GI as "data with a defined relationship to other data".

3.4 Conception four: geo/spatially technology-mediated

In this conception, GI is seen as any type of data that can be read and used by GIS. From this perspective, GI originally can be in any format but needs the mediation of geo/spatially and/or non-geo/spatially enabled technologies and tools to become geo/spatially meaningful and usable.

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 [only] data that can be handled by GIS '. 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). Likewise, this has been illuminated in the perceptions that identify the very nature of GIS 'to do with having spatial information on computers and using that to analyse spatial patterns' or more broadly 'to do with maps on computers' (1SL-1). Further details on the mediation role of GIS in making sense of, and use GI have been discussed in Nazar'si (2010b) describing the GIS conceptions of the same population

There are also some statements that illuminating this conception in a more implicit way. For example, R16 describes GI as "visually representing features on the earth's surface, with attribute data that can be used to solve problems or analyze trends". R19 states that "geographic data allows us to visualize spatial relationships in beautiful and dramatic ways".

According to the findings, GI may appear in any format. This includes tables of data or information (2AP-25, 23), points, lines, polygons (3AP-26), columns of spreadsheets (10AP-4), and "tabular form associated with a location" (3AP-5), coordinates in a database" (10AP-4), "old and digitised maps" (2AP-25, 23), "images" or "digital objects" (1AP-9), "aerial photographs" (8AP-20), and "graphs, on spreadsheets, on paper" (7AP-28).

4. Characteristics of Geo/spatial Information

Drawing on the four conceptions of GI, overall GI can be characterised with three main interrelated features: a) GI has several components that needs to be associated to each other properly to produce geo/spatially meaningful and usable GI which will be called multi-components; b) thus to make sense of, and use GI various operations may be needed that involves using different GIS and non-GIS tools; c) likewise, to make sense of, and use GI it requires various user inputs.

There are some similarities between the conceptions of GIS that emerged from this study and those that emerge in the GIS literature, for example as discussed in the context of the GIS curriculum model proposed by DiBiase et al. (2006). However, examining this aspect (which is discussed in depth in Nazari (2009) is outside the scope of this article, since here we concentrate on GI from an IL perspective.

Indeed as has been displayed in Figure 1, due to the multi-components nature of GI it requires various operations and user inputs to become geo/spatially meaningful and usable for various purposes. From this perspective, the multi-components nature of GI can be seen as a characteristic that influences the other two characteristics.

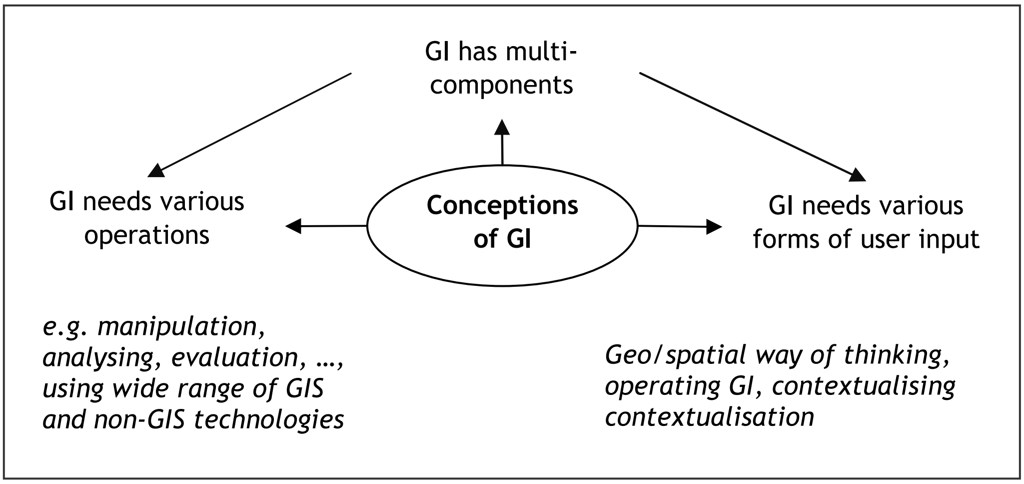

Figure 1. Characteristics of GI

Thus, the characteristics of GI are discussed in two sections in the following paragraphs: a) GI needs various operations; b) GI needs various forms of user inputs; and within each characteristic the multi-components is highlighted.

GI needs various operations

As has been displayed in Figure 2, time, location, and attributes are inseparable components of GI. GI can be in any format. However, to make sense of (or form it as geo/spatial data) and use it (or transform it to geo/spatial information and/or knowledge) it needs wide range of operations.

Indeed, time, location and the attributes can be seen as intrinsic components of GI and geo/spatially technology-mediated and geo/spatially contextualised are the acquisitive components of GI that contribute to the formation and transformation of GI. The latter components are acquisitive because they contribute to the accomplishment of operations needed to make data geo/spatially meaningful (form it) and then to make it useable and use it for various purposes (transform it). From this perspective, data cannot become GI unless it is viewed geo/spatially or it is operated in a way that its intrinsic components are overlaid and attached to each other in a geo/spatially meaningful way.

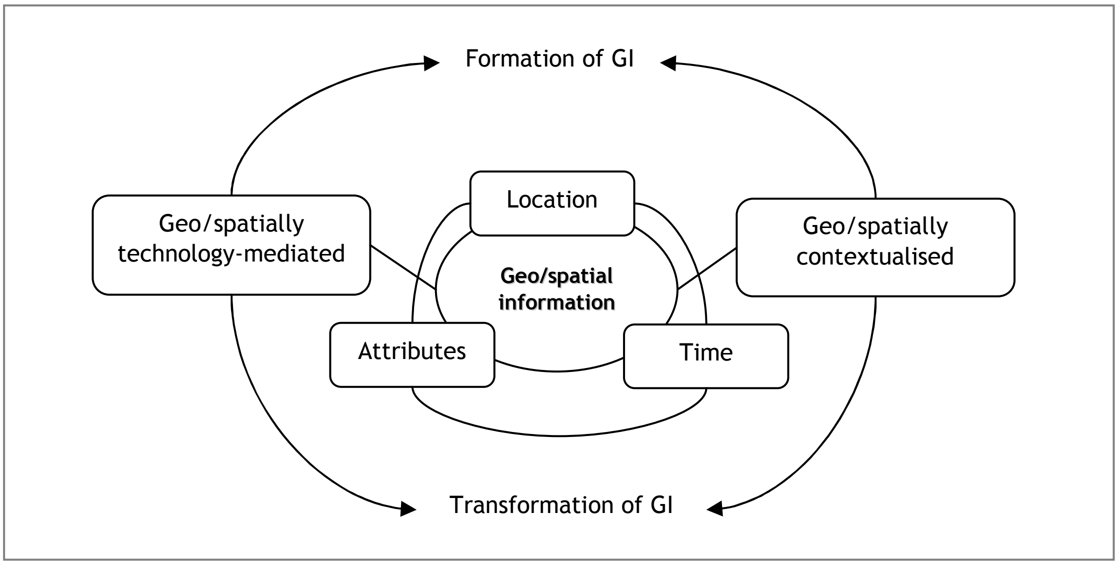

Figure 2. A portrait of the conceptions of GI

This means to form and transform or to make sense of, and use GI there is a need for wide range of operations that may vary depending on the format of existing data and way of using it.

Figure 3 demonstrates the process of formation of geo/spatial data and then its transformation to geo/spatial information and knowledge and highlights some operations and input it requires to become geo/spatially meaningful and usable for different purposes.

To form or make sense of GI there is a need for geo/spatial way of thinking of, and perceiving geo/spatial data (GD). In addition to the mind of user that may be able to visualise and perceive data three/four dimensionally in his mind, GIS tools can also contribute to the operations needed to visualise and display data with its time, location and attributes components associated with it.

To transform GD to geo/spatial information (GI) then it requires mediation both GIS and non-GIS tools and operations that contribute to the manipulations needed to create, capture, analyse, evaluate, handle, and use GI for different purposes.

Then to transform GI to geo/spatial knowledge (GK) it may require some operations that would contribute to the application of GI or use of GI in some real contexts and problems. This may vary depending on the purpose of using GI. For example, GI may be used to make particular decisions on where to open new supermarkets or make a particular plan for constructing hospitals in a city. In such situations, GI needs to be contextualised in the subject area, problem scenario, and location area where it is going to be applied. This may include some other contexts around the GI and purpose of using it. For example, to make a decision regarding where to establish new hospitals understanding various contexts such as social, economic, and educational may play a key role and therefore they need to be taken into account when transforming GI to GK.

Similarly, GK can be used as data for some other purposes. Thus the process of formation and transformation of GI is iterated for different purposes.

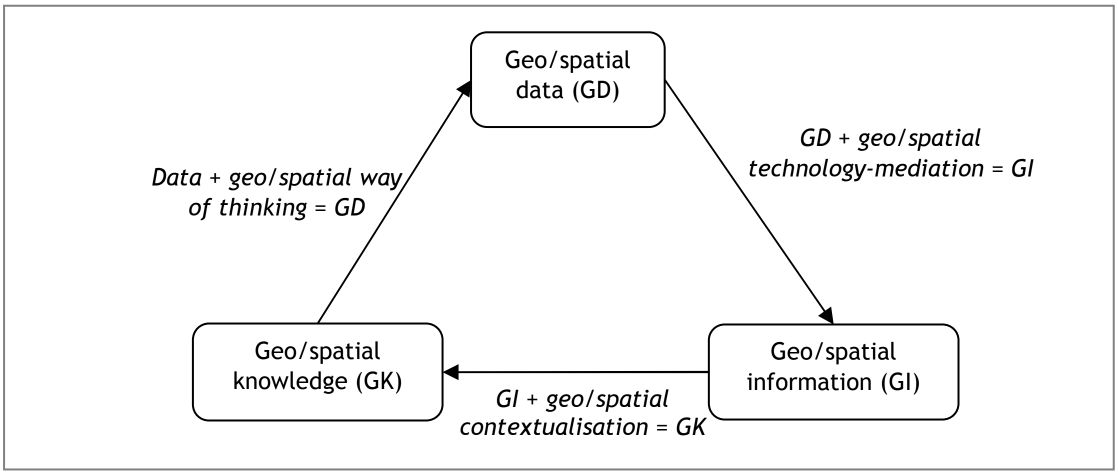

Figure 3. Forms of user input in the formation and transformation of GI from data to knowledge

To perform such operations various user inputs and skill-sets are needed. Highlighting the various forms of user inputs in each conception of GI, the needed knowledge and skills to form and transform GI are discussed in the following section.

GI needs various forms of user inputs

As was mentioned above the user may contribute to geo/spatially perceiving and visualising GI, operating GI using GIS tools, and contextualising GI to apply it for different purposes. However, depending on the way of viewing and using GI, the type of user input may vary. As the conceptions of GI present variation in the ways of viewing GI, thus, In this section types of user inputs are discussed that have emerged from each conception.

Table 2 presents a description of the GI conceptions and the user input needed to make GI geo/spatially meaningful and usable in each conception.

In the first conception of GI, GI is geo/spatial with a location and some attributes components associated with it. To make sense of, and use it geo/spatially it requires users to visualise and perceive it three-dimensionally. For this matter, they may need to a) have awareness of this conception and characteristics identified for it; b) have a geo/spatial way of thinking of phenomena or seeing phenomena three/four dimensionally; c) some knowledge of the ways in which GI can become geo/spatially meaningful and usable for different purposes.

Table 2. Various forms of user inputs as emerged from variation in the conceptions of GI

GI Conception	Description of GI	User input
One	GI is geo/spatial, with a location and some attributes associated to it	To visualize and perceive it geo/spatially (three-dimensionally)
Two	GI is temporal with a time component represents the earth's features	To visualize and perceive GI geo/spatially (four-dimensionally) with its time and location components
Three	GI is geo/spatially contextualised data; it has multi-dimensional contexts e.g. geographic, social, educational, etc Need to be contextualised in its time, location, and subject area so that can be applied for a particular purpose e.g.	To contextualise and conceptualise GI as socially and geographically constructed information, using GIS tools and techniques, and his synthesizing skills

GI Conception	Description of GI	User input
	decision making etc	
Four	GI is geo/spatially technology-mediated data, can be in any format but needs to be in formats (e.g. x,y,z coordinates) so that can be readable by GIS	To operate GI using wide range of GIS and non-GIS tools and techniques, to make it geo/spatially meaningful and usable

In the second conception, GI is temporal; it represents the earth's features and therefore it changes depending on the changes of the earth.

In this conception, the user needs to be able to understand and visualise GI four-dimensionally i.e. viewing GI, its location and attributes components in certain point(s) of time. For this matter, he may need to a) have an understanding of this conception of GI; b) be able to visualise phenomena four-dimensionally; c) have some knowledge of ways in which GI as a temporal phenomenon can become geo/spatially meaningful and usable.

In the third conception, GI is geo/spatially contextualised data, that is, the concept of GI may vary in different contexts. Because GI is dynamic, its location and attributes may change in accordance with the changes in the earth and the contextual issues around the GI. For example, not only the number of literate people may change in a certain location as result of some economical, political and ecological changes, but also the concept of literate people and literacy may change in different periods of time in that particular location. In this regard, 11AP highlights the role of contextual issues around GI stating the concept of "forest" may vary for people living in different places (11AP-24). So, to make GI geo/spatially meaningful and applicable for particular purposes it needs to be conceptualised and perceived in the context of location, attributes, and time and with considering contextual issues around these components.

In the fourth conception, GI is geo/spatially technology-mediated data that requires mediation of both GIS and non-GIS tools to become geo/spatially meaningful and usable. This requires the user to a) have awareness of this conception of GI; b) have some knowledge of, and ability in, using wide range of GIS and non-GIS tools to do various operations on the data to make it geo/spatially meaningful and usable for various purposes.

Thus, to perform as a competent GIS learner requires having an understanding of all four conceptions of GI to gain a holistic view to GI, its characteristics and ways in which it can become geo/spatially meaningful and usable in different contexts and for various purposes.

5. Implications for information literacy

This study explored the conceptions of information in the GIS discipline to identify competencies needed to make sense of, and use, GI. Due to the technology-oriented and muti-dimensional characteristics of GI, a user input component emerged. Drawing on the user input elements of the GI presented in Table 2, in this section we discuss further how the nature of information in the GIS discipline influences the competencies required to be information literate with GI.

The IL model chosen for detailed comparison is the SCONUL 7 Pillars model of IL, which is widely used in the UK (Peters, 2004). The SCONUL diagram (Figure 4) identifies the seven key areas of competence in which a student is meant to develop, underpinned by library and information technology skills. The diagram makes it explicit that there is a progression path from novice to expert. A brief description of each pillars in included in Appendix 4.

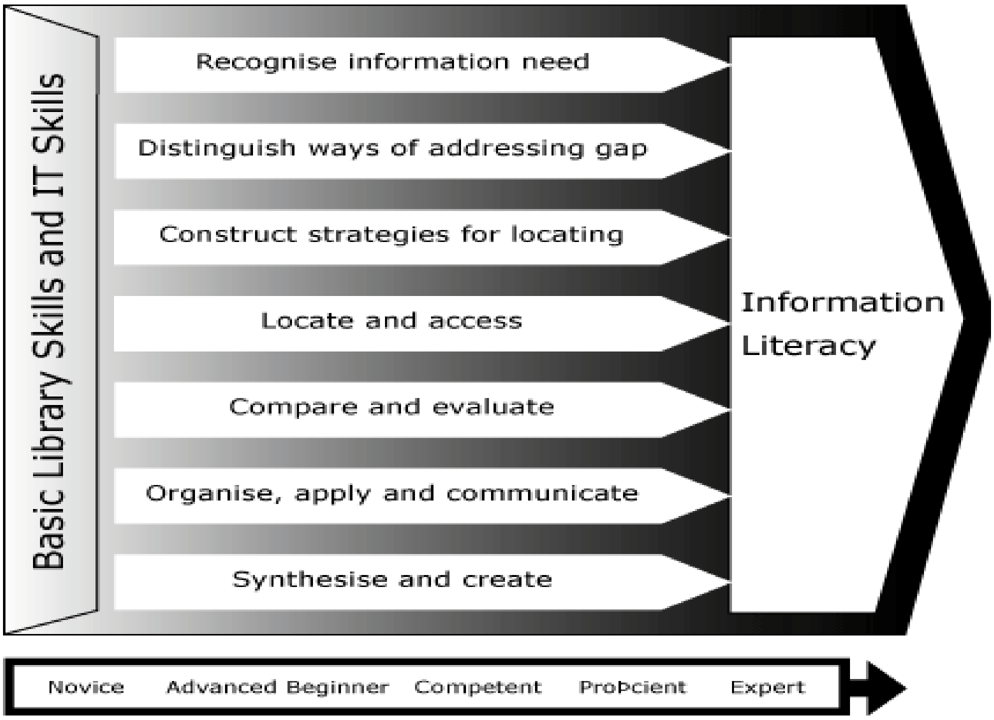

Figure 4. SCONUL seven pillar model of information literacy (SCONUL, 1999)

We start by addressing the concept of information implied by this model. According to our own findings, GI is a constructive phenomenon that requires several operations and user inputs to become geo/spatially meaningful and usable for different purposes. This is because GI is multi-dimensional and technology-oriented which means it has several components that need to be associated to each other properly to shape GI and that mainly involves using GIS and non-GIS tools and techniques. However, in the IL models such as SCONUL, information is positioned as an entity external to users, that exists in different formats and media. Although it may involve using information and communication technologies to access, produce, and present or communicate information, it does not require the majority of the operations identified in the GI conceptions to become meaningful.

As a result of differences in the nature of GI, it requires a wide range of operations that are mostly different from the ones identified in the generic models of IL, adding new competencies. In the following discussion we concentrate on these new competencies, rather than discussing those elements which are similar.

The new competencies can be indentified in four main areas as follows. Firstly, GI needs to be created and its creation requires using some GIS relevant tools and different methods such as capturing information about locations using GPS. This is comparable with pillar seven of the SCONUL model which focuses on “the ability to synthesise and build upon existing information, contributing to the creation of new knowledge”. However, data creation is different from pillar seven from two perspectives:

a) in the GI conceptions, the IL process starts with creating information, whereas in the SCONUL model this is part of the final stage of the IL process;

b) the nature and process of creating GI is technology-involved, that is, requires GIS and non-GIS tools to become meaningful, whereas in the SCONUL model this usually does not involve using technologies in the same way as GI.

In the SCONUL model users may use some information and communication technologies to design, type, and present information in an understandable and exchangeable way. In other words, some generic ICT tools may be used to transfer information to knowledge for example, in the form of “a critical business report building on analysing existing information to produce fresh insights and forecasts” (Webber, 2008). However, in the GI conception, creating data/information contributes to making it usable for further information processing, rather than output contributing to new knowledge.

We would also argue that this is different from SCONUL pillar six (“the ability to organise, apply and communicate information in ways appropriate to the situation”) since pillar six implies (through the structure and numbering of the pillars) that the focus is on the application of information to a real-world or scholarly problem, as the final stage in an information process. However, we refer to the creation of meaningful GI from data, as a necessary initial step. This adds a new component to the current IL competency called **creating information**.

Secondly, unlike IL models that assume understanding information mainly depends on the comprehension and synthesising skills, in the field of GIS, understanding information requires visualising it through mapping and overlaying different components of GI, using GIS tools. **Mapping and visualising information** are other IL components need to be added to the current models of IL: indeed the visualisation component could also be relevant to a number of other disciplines..

Thirdly, GI needs to be operated and manipulated to become meaningful and usable for particular purposes. Although GI can be originally in any format (e.g. text, number, image etc) it only can be used by GIS if it is in spreadsheet format. This would require doing various operations on the GI to pre-process (to get it ready for the GIS software) and to process it inside of the GIS software. This also adds a new competency component to the IL model called **information manipulation**.

Finally, due to the dynamic nature of GI it needs to be maintained. **Information maintenanc**e is another component which needs to be added to the current models of IL. This is different from people's ability in updating their knowledge in a specific subject area that has been highlighted in some of the IL frameworks such as ACRL (2000). In the GI conception, this focuses on updating information itself.

In addition to the breadth of the IL models, the multi-dimensional and technology-oriented nature of GI also impacts on the depth or content of IL competencies, i.e. finding, evaluating and using information. The multi-dimensional and technology-oriented nature of GI implies to find, evaluate, and use GI some new elements need to be taken into account which are beyond the territory of the current models of IL. For example, comparing the "finding information" pillars (2, 3 and 4) of the SCONUL model (1999) with GI as it emerged in the GI conceptions, because GI is any format, and to find it requires having knowledge of a broader range of information resources and ways by which they can be obtained. Depending on the subject context, location component of GI and its attributes, to obtain data on different aspects of GI different sources of information such as maps, tabular data, images and text may be needed and each of them may require different searching strategies and information seeking behaviour to get hold of them. In other words, this expands both the boundary of information need and types of information resources needed as well as information behaviour and literacy needed to locate and obtain the needed information. For example, due to the location component of GI, to search for GI it may require limiting searching strategy to a particular geographical location.

This, however, is different from the “finding information” pillar identified in the SCONUL model. In this model information is an entity external to users existing in specific formats and is accessible through certain media. Information need mainly is informed by “assignments and course work” and although it may require information on different aspects of the assignment topic, it usually applying specified searching strategies, in particular information resources such as books, journals, databases and the Internet (Webber, 2008).

Likewise, evaluating GI involves using GIS software to check the accuracy of GI; to see whether or not different components of GI have been appropriately associated to each other. If not, then it requires using GIS tools to overlay the components appropriately, whereas in the SCONUL model information evaluation (SCONUL Pillar 5) is mainly limited to investigating resources such as “author or publisher” of information resources and understanding ways in which the intended “media operate, and certain processes which are particularly important in the academic context” (Webber, 2008). Although, use of some specialist software to manipulate specific types of information such as “numeric and chemical” has been highlighted as part of the information evaluation, it is not as explicit and dominant as emerged from the GI conceptions in this study.

Overall, although processing and using information needs some user inputs such as information evaluation and synthesising, they do not put emphasis on the use of technologies to make sense of information. In other words, the process of transformation of information to knowledge mainly takes place inside of the head of users when synthesising information in terms of specific question or topic that they may have.

Looking at the GI conceptions more holistically, to perform the operations on the GI requires wide range of user inputs and accordingly wide range of skills and knowledge. This, however, varies in different conceptions of GI. The variation in the ways of viewing GI and’ accordingly’ in the range of competencies and user inputs may be needed to make sense of, and use GI implies that to perform as information literate individuals learners need to be able to a) determine their way of viewing or conception of GI and then b) identify the set of knowledge and skills they need to make sense of, and use it effectively.

This also requires curriculum design and pedagogical approaches that support learners developing their understanding of the nature and characteristics of GI and identifying their input and competency needs to make sense of, and use GI.

6. Conclusion

Overall the contributions of this study can be identified in three aspects as follows: methodologically, understanding IL and in contributing to the discipline of GIS. Methodologically, people's conceptions of information can be seen as a key construct in IL research as it enables exploration and illumination of one of the key contextual aspects of IL. According to the results of this study, understanding what information means to people in different contexts and disciplines helps to identify characteristics of information and figure out competencies needed to interact with and use information in that particular context or discipline.

According to the conceptions and characteristics of GI, information is not an entity external to users which exists in books, journals and other sources of information as has been defined in the generic models of IL (e.g. ACRL, 1989; SCONUL, 1999). GI is a constructive phenomenon needs to be conceptualised by users. Thus, it requires a wide range of user inputs and operations to not only use it but also to make sense of it.

Results of this study contribute to our understanding of IL in the GIS discipline: an area that has not been directly researched. This contributes to the depth and breadth of current IL models as it brings new perspectives to the information element of IL models that emerged from a novel disciplinary area and conceptions of people who directly experienced information in the context of the discipline. Comparing IL in the GIS discipline as emerged from this study with the SCONL model, it appears that the generic models of IL are not adequate to be transferred and implemented in the GIS discipline as they do not address competencies individuals need to make sense of, and use information in this discipline. Indeed, this re-confirms results from other disciplinary research of IL which see IL as a phenomenon that is defined in the context of people's meaning of information and informed by the nature of disciplines (e.g. Webber et al., 2005; Boon et. al., 2007).

Finally, from a disciplinary point of view, this study also contributes to the IL practices in the field of GIS, particularly when designing and delivering GIS education that intends to produce information literate individuals (Jablonski, 2004; Massey, 2002).

Acknowledgement

This study received awards and scholarships from the Worldwide Universities Network (WUN) and John Campbell Trust. It also received the sincere support of several academics and students in the Universities of Leeds, Southampton and Penn State, in particular Mr David DiBiase' supervision in Penn State site. We would like to acknowledge all their contributions to this study.

References

Association of College and Research Libraries (ACRL) (1989), "ALA presidential committee on information literacy: final report", available at: *http://ala.org/ala/mgrps/divs/acrl/publications/whitepapers/presidential.cfm (accessed in 18 November 2009).*

Association of College and Research Libraries (ACRL) (2000), "Information literacy competency standards for higher education: introduction ", available at: *http://archive.ala.org/acrl/il/toolkit/intro.html#highered (accessed in 18 November 2009).*

Bawden, D. (2001),"Information and digital literacies: a review of concepts", *Journal of Documentation*, Vol. 57 No. 2, pp. 218-259.

Boon, S., Johnston, B. & Webber, S. (2007), "A phenomenographic study of English faculty's conceptions of information literacy", *Journal of Documentation*, Vol. 63 No. 2, pp. 204-228.

Bruce, C. (1997), "*Seven faces of information literacy"*. Adelaide: Auslib Press.

Cutcliffe, J.R. (2000), "Methodological issues in grounded theory", *Journal of Advanced Nursing*, Vol. 31 No. 6, pp. 1476-1488.

Denscombe, M. (2003), "*The good research guide: for small-scale social research projects"*. England: Open University Press.

DiBiase, D. et al. (2006), *Geographic Information Science and Technology: Body of Knowledge*. UCGIS.

Dooley, L.M. (2002), "Case study research and theory building", *Advances in Developing Human Resources*, Vol. 4 No. 3, pp. 335-354.

Eisenhardt, K.M. (1989), "Building theories from case study research", *The Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Glaser, B. & Strauss, A. (1967), "*The discovery of the grounded theory: strategies for qualitative research"*. New York: Aldine de Gruyter.

Jablonski, J. (2004), "Information literacy for GIS curricula: an instructional model for faculty", *Journal of Map & Geography Libraries,* Vol. 1 No. 1, pp. 41-58.

Leckie, G.J. & Fullerton, A. (1999), "Information literacy in Science and Engineering undergraduate education: faculty attitudes and pedagogical practices", *College and Research Libraries*, Vol. 60 No. 1, pp. 9-29.

Lloyd, A. (2005), "Information literacy: different contexts, different concepts, different truths?", *Journal of Librarianship and Information Science*, Vol. 37 No. 2, pp. 82–8.

Lloyd, A. (2009), " Informing practice: information experiences of ambulance officers in training and on-road practice", *Journal of Documentation*, Vol. 65 No. 3, pp. 396-419.

Lupton, M. (2008), "Information Literacy and learning", Unpublished PhD thesis, Faculty of Information Technology. Brisbane: Queensland University of Technology.

Massey, M. (2002), "National collaborative projects for information and spatial literacy", *Information Technology and Information Literacy Conference*, University of Glasgow, available at: http://www.iteu.gla.ac.uk/elit/itilit2002/papers/ab18.html *(accessed in 18 November 2009).*

Nazari, M. (2009) Information literacy for online distance learning GIS programmes. Unpublished PhD thesis. Sheffield: University of Sheffield, Department of Information Studies.

Nazari, M. (2010), "Design and process of a contextual study of information literacy", Library and Information Science Research, due to publication in 2010.

Peters, J. (2004), "Learning outcomes and information literacy", Society of College, National and University Libraries (SCONUL), available at: http://www.sconul.ac.uk/groups/information_literacy/publications/papers/outcomes.pdf *(accessed in 18 November 2009).*

Pickard, A. J. (2007), "*Research methods in information",* London: Facet Publishing.

SCONUL (1999), "*Information skills in higher education: briefing paper,* SCONUL Advisory Committee on Information Literacy.

Seidman, I.E. (1998), "*Interviewing as qualitative research: a guide for researchers in education and the social sciences",* New York; London: Teachers College Press.

Stake, R.E. (1998), "Case studies", In: Denzin, N.K. & Lincoln, Y.S. (eds.), *Strategies of qualitative inquiry*, pp. 86-109. London: Sage.

Talja, S., Maula, H. (2003), "Reasons for the use and non-use of electronic journals and databases: a domain analytic study in four scholarly disciplines", *Journal of Documentation*, Vol. 59 No. 6, pp. 673-91.

The Chartered Institute of Information and Library Professionals (CILIP) (2006), "A short introduction to information literacy", available at: http://www.cilip.org.uk/policyadvocacy/learning/informationliteracy/definition/introduction.htm *(accessed in 18 November 2009).*

Webber, S. (2008), "The seven headline skills expanded", available at: http://www.sconul.ac.uk/groups/information_literacy/headline_skills.html *(accessed in 18 November 2009).*

Webber, S., Boon, S. & Johnston, B. (2005), "A comparison of UK academics' conceptions of information literacy in two disciplines: English and Marketing ", *Library and Information Research,* Vol. 30 No. 93, pp. 4-15.

Webber, S. & Johnston, B. (2000), "Conceptions of information literacy: new perspectives and implications", *Journal of Information Science*, Vol. 26 No. 6, pp. 381-397.

Wu, Y.D. & Kendall, S.L. (2006), "Teaching faculty's perspectives on business information literacy", *Reference Services Review*, Vol. 34 No. 1, pp. 86-96.

Yin, R. (2003), *Case study research: design and methods,* London: Sage.

Yin, R. K. (1994), *Case study research: design and methods,* London: Sage.

Appendices

Appendix 1. GIS courses selected in this study

Courses studied at the UK sites	Courses studied at the US site
Principles of GIS	The Nature of Geographic Information
Using databases and GIS	Problem-solving with GIS
Spatial Analysis and GIS	GIS Database Development
GIS in the workplace	Geospatial System Analysis and Design
Introduction to Java programming	Cartography and Visualisation
Geo-demographics and Database Management	GIS Programming and Customization
Census Analysis and GIS	GIS Application Development
GIS and Geo-computation	Environmental Applications of GIS
Retail Decision Support Systems	Individual Project Work Supervised by a Graduate Faculty Advisor
GIS and Planning	
Applied Environmental GIS	
GIS for Environmental Management	
GIS for analysis of Health	
GIS for Health Care Management	
Dissertation	

Appendix 2. Profile of students who were interviewed

No	Code	Study site	Taken courses	Background	Ambition	ID	IL
1	1SL	UK	1- principles of GIS 2- GIS in databases 3- spatial analysis 4- GIS in workplace	Computers, IT a first degree and a PhD in town planning	To become professional in her main field of work For self satisfaction Just loving geography and computers	19/02/07	62
2	2SL	UK	1- principles of GIS 2- GIS in databases 3- spatial analysis 4- GIS in workplace 5- GIS for analysis of Health 6- GIS for Health care management 7- Geocomputation and GIS	First degree in psychology and math Working in the Geography field in academia, using GIS for mapping and analysis	Learning GIS to fill the knowledge gap in his current profession	16/03/07	59
3	3SL	UK	1- principles of GIS 2- GIS in databases 3- spatial analysis 4- GIS in workplace	First degree in Geography; Computer or IT background only with Microsoft office(excel, access, word) With very limited experience of statistical packages and GIS Works as GIS analyst	Taking the GIS distance courses to him a better professional at his workplace.	19/03/07	51
4	1SP	US	The nature of Geographic information Problem-solving with GIS GIS database development Environmental applications of GIS	I have B.A., M.S., and Ph.D. degrees in geology	I thought it would be useful to learn the basics of GIS because these techniques are now used so much in the geology, environmental, and engineering professions.	21/12/07	110
5	2SP	US	Geographic information Problem-solving with GIS GIS database development GIS programming and customization	B.S. in Regional Planning Working as Airport Planner	To solve problems with GIS in the air port field	4/01/07	40
6	3SP	US	Geographic information Problem-solving with GIS	First degree in Geology Work as environmental consultant	To keep a pace with technological advancements in his field of work and gain the ability to use GIS in his profession Personally interested in and fascinated with maps and representing things	20/12/06	65
7	4SP	US	Geographic information Problem-solving with GIS GIS database development GIS programming and customization	BS in Biology, Token undergraduate classes in engineering principles and design. Profession: project	For her profession: project management Personal interest A way to communicate with people about spatial things, to people who don't know anything spatially	5/01/07	80

No	Code	Study site	Taken courses	Background	Ambition	ID	IL
				management			
8	5SP	US	Geographic information Problem-solving with GIS GIS database development GIS programming and customization Geographical information analysis Geospatial system analysis and design GIS application development Geospatial technology project management Geographical information analysis	BA in Geography and Sociology Working in Geography field Previous professional background: worked in a computer software company as a programmer and database administrator	To specialize more in Geography (advancements)	13/12/06	70

The abbreviations used in the Appendix stand for:

"ID" for "Interview Date", and "IL" for "Interview Length".

Appendix 3. Profile of students who responded questionnaire

Code	Study site	Background Educational	Background Professional	Ambition for taking GIS
PQ1	US	BS and MS in Biology	Senior Extension Educator	No response
PQ2	US	Master of Political Science, Master of Community and Regional Planning BS in Criminology	- Teaching in the fields of Geographic Information Systems, Regional Planning and Geographic Information Systems for the Walter Rand Marketing Systems - Managing Director of Geodemographics	
PQ3	US	Master degree in Forestry	Working for the US Forest Service	to expand my set of skills
PQ4	US	Ph.D. in Microbiology and Biochemistry	Environmental consultant and teacher	To understand the principles and power of GIS Using GIS as a valuable tool in the evaluation of potential employees
PQ5	US	Master degree Geology	Mathematical modeling and hydrogeology	To fill a knowledge and skill gap in his education and profession
PQ6	UK	MA in Business	IT Investment Banking Mobile Telecoms industry	Personal interest in Geography and The World, As educator learning GIS can open some opportunities the future
PQ7	US	BA in Geography	IT administrator	To keep a pace with technological advancements in his profession
PQ8	US	I have a BS in Geography from a State school in Pennsylvania. Additionally I achieved the GIS Certification from Penn State's World Campus.	GIS Coordinator of a medium sized county in Pennsylvania Worked for a public utility doing GIS work and for a private sector engineering firm as a GIS specialist/analyst	To improve his profession and work with GIS software
PQ9	US	No response	Planning leader of a region in the US	Planning encompasses GIS. In order to be successful at his profession and expand his knowledge took the GIS courses
PQ10	US	MS in Geography	US Geological Survey Assistant Professor in the field of Geography Software Scientist Systems Engineer	To become proficient in the use of the ESRI product line
PQ11	US	BFA in Illustration (graphic and structural design)	Digitizing stereo images, and assist in the development of emergency management software	To improve her profession
PQ12	US	BS in Economics	Computer networking, specifically in Sales for 15 years	to explore other career options Personal interest in Geography, maps, and data

Appendix 4. A summary of the expanded version of the Seven Pillars of SCONUL

Pillar 1. The ability to recognise a need for information: This pillar is concerned with recognising that you have an information need, and being able to analyse that need.

Pillar 2. The ability to distinguish ways in which the information 'gap' may be addressed: This involves identifying the gap between what you know already, and what you need to know to meet your information need. Mastery of this Pillar involves not just knowledge of what resources are available, but also being able to identify which ones would be a "best fit" for the task in front of you.

Pillar 3. The ability to construct strategies for locating information: This pillar involves understanding that you need to learn something about how each kind of information resource works (whether a person, a search engine or a journal), so that you can construct an effective strategy to get the best out of that resource.

Pillar 4. The ability to locate and access information. This pillar requires the knowledge and skills to access the information resource and extract the information from it. This Pillar does not just cover search activities, but also other activity such as effective browsing and monitoring of sources.

Pillar 5. The ability to compare and evaluate information obtained from different sources. What is important in this pillar is being able to evaluate the piece of information in front of you carefully and critically in relation to your information need.

6. The ability to organise, apply and communicate information to others in appropriate ways. This pillar also includes being aware of ethical and legal issues in applying information.

Pillar 7. The ability to synthesise and build upon existing information, contributing to the creation of new knowledge. Someone who is adept in the seventh Pillar will be able to identify, select, compare and analyse needed information to produce a synthesis which provides a new perspective, and which may enable the creation of new knowledge

The 7 Pillars model was developed by the SCONUL Working Group on Information Literacy and is the intellectual property of SCONUL. It is made available to use freely as people want, but SCONUL should be acknowledged when using it. See http://www.sconul.ac.uk/groups/information_literacy/seven_pillars.html